In this Issue: Prof. Geo. F. Swain on Efficiency in Engineering Education.—Analysis of Concrete Arch Stresses.—Standard Specifications for Underground Piping, Seattle, Wash.—Engineering Literature Supplement.

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The New Timber Treating Plant of the Eppinger & Russell Co. at Jacksonville, Fla.

By GRANT B. SHIPLEY.*

The Eppinger & Russell Co., of New York, which is one of the oldest timber preserving firms in this country, has recently started operating its new plant at Jacksonville, Fla., on the St. John's River. The site is about 600 × 1,600 ft.; it is adjacent to a dock 180 × 500 ft.; and a pile basin 135 × 300 ft. The arrangement throughout is ideal for the handling of incoming and outgoing ties, piling and lumber by either rail or water transportation. A general plan is given in Fig. 2, and Fig. 1 is a view of the main building, with tram cars standing on the cylinder tracks.

The tracks in the storage yard and on the dock consist of three-rail tracks for tram cars of 30 ins. gage and standard-gage cars. The main ladder track is on one side and parallel with the length of the site, with seven branches at 116 ft. centers leading away from the ladder at an angle of 30°. Each branch consists of two three-rail tracks spaced 16 ft. centers. The object of these two tracks is to expedite loading, as a locomotive crane on one standard-gage track can load or unload either narrow-gage trams or broad-gage cars on the other track. Three 30-in. tracks lead to and from the treating cylinders, being spaced 12-ft. centers; they are arranged so that either untreated or treated timber can be run into the cylinders from either end. All rails weigh 60 lbs. per yd. and are laid on 8-ft. ties 6 × 8 ins., in sand ballast. The diagonal arrangement of the tracks is economical in facilitating the handling, switching and storage of both the untreated and the treated timber.

For moving the tram cars and railway cars there is a 23½-ton, four-wheel, tank locomotive. For handling the heavy timber and piling there are two eight-wheel locomotive cranes, each having one 30-ft. and one 50-ft. boom, rated for 15 tons at 10 ft. radius and 2 tons at 50 ft. radius. Each crane weighs about 48 tons. When moving the loaded tram cars around the yard, or pushing them in and hauling them out of the cylinder, a push-car of composite steel and timber construction is coupled to the locomotive and placed between it and the first tram, as couplings cannot be used on the tram cars. This arrangement is shown in Fig. 3. On the car is mounted a drum for carrying the cable used in pulling the tram cars out of the cylinder; the drum has a spur wheel, gearing with a pinion on a shaft fitted with a crank handle, by means of which the slack in the cable can be taken up. In pushing loaded trains into the cylinder or around the yard the car acts as a bumper, its end butting against the load of timber on the first tram. When pulling, the cable is unreeled and passed over the loads (under the curved bails) and fastened to the rear of the load on the last car; the slack is then taken up by the drum. As the locomotive moves forward, the cable pulls the train of tram cars by its attachment to the rear car.

For handling the ties, timber, piling, etc., to and from the cylinders there are 90 tie cars and 60 bolster cars of heavy construction. The longitudinal frames are made of pressed steel and have secured to them four wheels fitted with roller bearings, steel bushings and shafts secured in heavy boxes. The arms on these cars are made of reinforced channels. For handling paving blocks, there are 15 baskets; the heads and shells are of perforated plate, and each head has secured to it a cast-steel trunnion so that the basket can be elevated by bails from the crane and then turned so as to dump the load. These baskets can be mounted on the bolster cars when the arms of the latter are removed.

The buildings are located near the river and consist of the following: (1) structural steel main building enclosing the cylinders, working tanks, pumps, compressor, generator, boilers, etc.; (2) structural steel machine shop, (3) reinforced-concrete fuel house, (4) reinforced-concrete oil and tool house, (5) frame office building, (6) frame laboratory, and (7) frame storehouse. All buildings are over marshy formation and river bed, therefore it was necessary to support the concrete foundations on piling. The main building and its machinery are supported on about 300 piles and about 2,200 cu. yds of concrete. The concrete floors are reinforced with steel bars and lined with waterproofing paper below the high-water mark. The main building has corrugated-iron roofing and siding, steel rolling doors, and wire-glass windows set in pivoted iron frames.

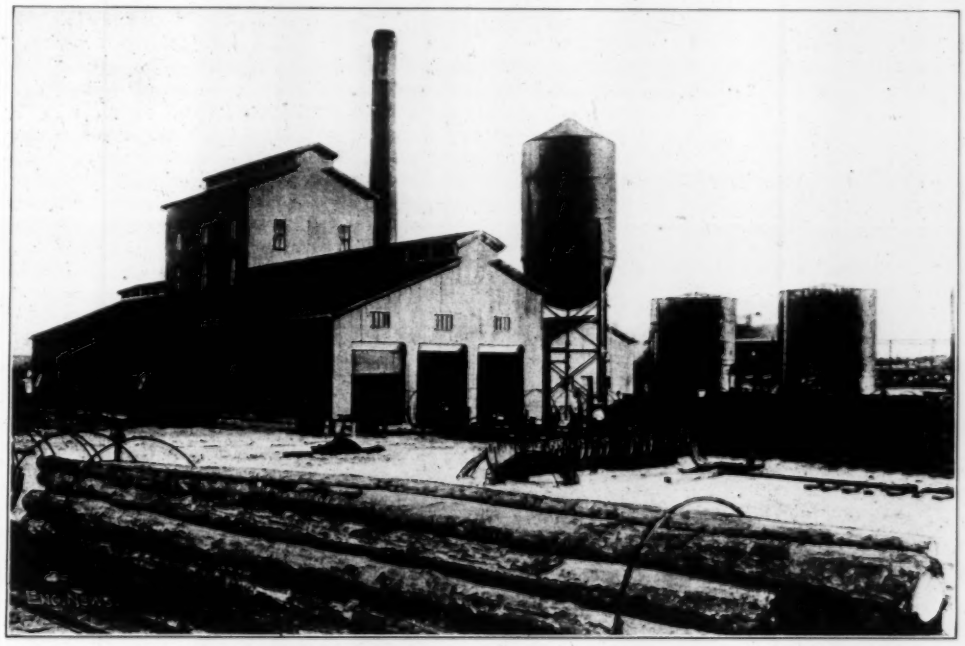

FIG. 1. CYLINDER HOUSE AND TANKS OF THE NEW TIMBER TREATING PLANT.

On one side of the main building is a concrete settling basin and hot well. Each oil storage tank has a circular concrete foundation wall, the center of which corresponds to the diameter of the tank. This wall is about 3 ft. high and encloses a flat slab about 12 ins. thick; the enclosed space is filled with sand to the bottom of the tank, thus permitting flexibility. There are about 140 piles to each of the two smaller tanks and about 230 piles to the large tank.

It is very essential to have a large oil storage capacity, and this plant has one 500,000-gal. and two 150,000-gal. creosote tanks, each equipped with steam heating coils, floats, indicator boards and thermometers. The coils in all oil tanks are arranged in sections connected to both inlet and outlet manifolds, and so arranged that a leak in one set of coils could be located and thus would not interfere with the operation of the entire set.

Steam for heating the tanks is brought from the boiler room (about 300 ft.), and can be con-

*Engineer of the Mining Machinery and Timber Treating Department, Allis-Chalmers Co., 447 Marshall St., Milwaukee, Wis. A paper by Mr. Shipley on "A Comparison of the Various Processes of Preserving Timber" was published in our issue of Oct. 14, 1909.

trolled at either the boiler room or at each tank. The coils are proportioned so that the oil can be kept at a temperature of 200° F., if necessary. However, the normal temperature of oil will be about 130°. For measuring the oil accurately, the gage board is graduated to read in gallons on one side and in feet and hundredths on the other side. A fresh-water storage tank of 45,000 gals. capacity furnishes water to the boilers, condenser and fire line.

There are three treating cylinders 7 × 132 ft., designed for a working pressure of 200 lbs., and

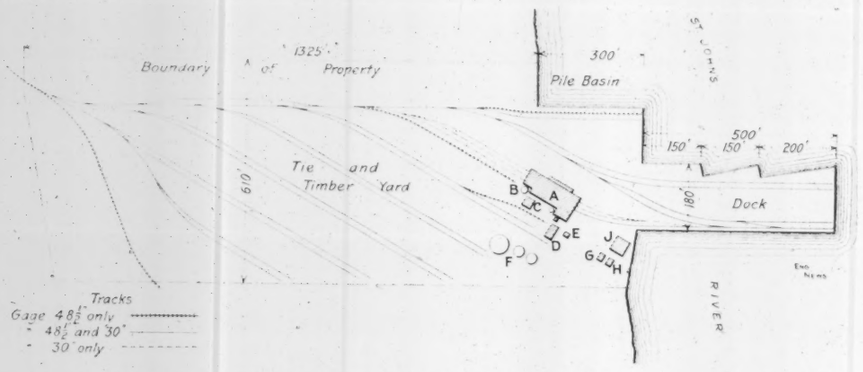

FIG. 2. TIE AND TIMBER TREATING PLANT OF THE EPPINGER & RUSSELL CO., AT JACKSONVILLE, FLA.

A. Main building.
B. Water tower.
C. Machine shop.
D. Fuel bin.
E. Fire pump house.
F. Oil storage tanks.
G. Storehouse.
H. Laboratory.
I. Offices.

having a door on each end. A cast-steel frame riveted to the shell supports a door made up of a cast-steel ring (with hinges) welded to a flanged steel center plate; the door ring also has an annular rib that matches an annular groove in the frame on the shell. The grooves are lined with special wire-woven asbestos gaskets. Each door is held in place by 36 swing bolts 2½ ins. diameter, and the door hinges are carried upon roller bearings, thus reducing the power required in opening and closing. Each cylinder is supported near the center by a stationary steel saddle riveted to the shell and anchored to concrete piers by foundation bolts. At each end of the cylinder there is a steel saddle riveted to the shell and arranged for sliding on foundation plates, thus taking care of the contraction and expansion, which amounts to about 1½ ins. for a temperature of 240°. On the intermediate courses there are other expansion saddles.

Each cylinder is fitted on the inside with angles which form the rails and guards. For heating the oil, there is extra heavy piping placed between these rails and arranged in sections with inlet and outlet connected to cast-steel manifolds at two different positions on the shell. This permits control of the steam coils from the outside of the cylinder. These coils are protected the full length of cylinder by perforated steel plates. On the upper part of each cylinder is a dome containing an automatic float and valve, arranged so that when the oil or preservative fills the cylinder and enters the dome, the float rises quickly and closes the automatic valve, thus obviating any possibility of the oil overflowing. When this closes it automatically rings a gong to warn the operator. For taking the temperature, each end of the cylinder has a bracket which contains a socket for a removable thermometer. For charging or discharging the preservative, the cylinder has two 10-in. nozzles on the bottom, and for drawing the vacuum and exhausting the steam and admitting air there is a flanged connection on the top of dome.

For providing the necessary oil to operate the three cylinders, there are two 42,000-gal. covered working tanks supported on structural steel framework about 10 ft. above the cylinders. These tanks are provided with heating coils, floats and vertical board indicators for accurately measuring the oil that enters the cylinders. The indicators are graduated in feet (and hundredths) and gallons. The coils in each tank are divided into sections and are connected to both inlet and outlet manifolds with valves on the outside for controlling the steam; they are so proportioned that a temperature of 240° can be obtained at a steam pressure of 35 lbs. On the bottom of each tank there is a 10-in. outlet which leads to either of the three cylinders, and on the outside near the top of each tank there is a 4-in. pipe for the return of oil that is blown back by air from the cylinder.

At each end of the three cylinders there is a track running the full width of the building, on which is carried a transfer tram, which can be run in front of either of the cylinders for connecting the track outside of the building to that in the cylinder. This transfer car, which is shown in front of an open cylinder in Fig. 4, is made up of a structural steel frame carrying 60-lb. rails, and is mounted on four wheels having roller bearings.

For supplying the compressed air required in the operation of modern processes and for forcing the oil from the cylinders to the working tanks, there is a duplex compound air compressor having a capacity of about 700 cu. ft. of free air per minute at 100 lbs. pressure. This compressor discharges into an air receiver 5 × 16 ft., and the receiver is connected by a small return pipe to the compressor governor, thus securing automatic regulation. There is one general service pump arranged with a suction and discharge header, each connected to the cylinders, storage tanks, working tanks and pipe line leading to dock. This pump is arranged so that oil from any one of the storage tanks can be discharged into either of the other storage tanks.

For maintaining the necessary pressure in treating material in the cylinders, there are two high-pressure, piston, duplex, oil pumps of special design, arranged so that either pump can be used on either cylinder. For creating the vacuum, there is a duplex, crank-and-flywheel, vacuum pump arranged with jet condensing bell above the water cylinders. This bell is connected to the top dome on each of the cylinders. Injection water for condensing can be taken either from the water tower or the salt-water fire line. For collecting the creosote or preservative that is drained from the cylinder after treatment, there is a horizontal tank 5 × 20 ft. placed in the pit below the cylinder and arranged so that its contents can be blown back to either of the working tanks.

A duplex piston pump draws the water from several 2½-in. surface wells through a 5-in. pipe about 1,000 ft. long, and this pump discharges into the elevated tank. The electric current for lighting the plant, buildings and yard is generated by one 22½-KW. generator directly connected to a vertical engine.

There are three 150-HP. tubular boilers (125 lbs. pressure), placed in a single brick setting, with separate flues leading to a common breeching and thence to a 5-ft. brick stack, 100 ft. high. The exhaust steam from the various machines may be discharged into a Hoppes open feed-water heater, or into the atmosphere. A duplex piston-pattern feed pump is arranged to pump the water from the heater, hot well or fresh water tank and discharge into either of the boilers, and for each boiler there is also supplied an injector. The boiler room is built in with the main building, but is separated from the machinery room by a 6-in. reinforced-concrete partition with a steel door.

The piping throughout the plant is arranged so that any of the modern processes of treatment can be used, and in order to enable any cylinder to be operated independently several lines of piping for different movements were necessary. In order to economize on the steam used, the steam piping is so arranged that exhaust steam or reduced pressure steam can be used in the heating coils.

In connection with this plant there is an experimental equipment consisting of one cylinder 2 × 8½ ft. designed for a maximum working pressure of 400 lbs. This is fitted with steam coil, air pipes, circulating pipes, thermometers, gages, etc., and has a door at one end. An experimental pressure tank 3½ × 5½ ft. can be used as a measuring or working tank for any modern process. A small piston pattern, duplex, high-pressure pump is connected to both cylinder and tank.

The yard and docks are protected by fire hydrants supplied by a 6-in. fire line. In all there are about 2,300 ft. of 6-in. cast iron pipe. The water for fire purposes is pumped from the river through a 12-in. cast iron suction line by one underwriter fire pump having a capacity of 1,000 gals. per minute. This pump is located in a separate reinforced-concrete building about 50 ft. from the boiler room and receives steam direct from the main boiler. It is kept running continually (but very slowly), and the fire line is arranged to supply the condenser with injection water.

The shavings from the saw mill (about 700 ft. from the boiler room) will furnish the fuel. They are conveyed by a drag conveyor to the concrete fuel house near the boiler room. The

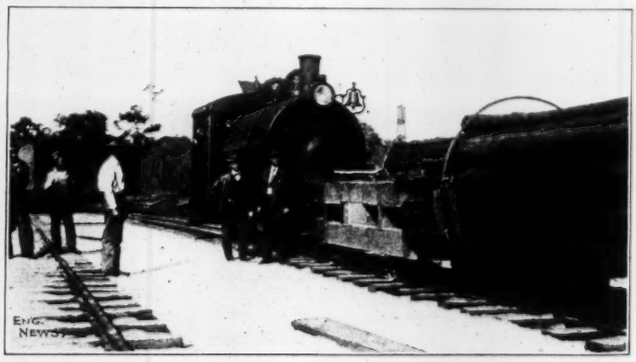

FIG. 3. LOCOMOTIVE AND BUMPER CAR (WITH CABLE) FOR HANDLING THE TRAM CARS.

bins in this house have gates which open into a drag conveyor that elevates the material over the top of the boilers and drops the shavings into the furnace. The conveyor is driven by a small vertical engine which receives steam from the main boiler. The fuel bins are fitted throughout with pipes for fire protection.

For controlling the operation of the plant, there is in the pump room a large steel gage board with two circular indicator clock dials, one for each working tank. These are graduated in feet and hundredths, thus permitting accurate measurements of oil. The board also contains

r the large cylinder, a recording pressure gage, recording steam gage, a recording vacuum ge, and an ordinary pressure, steam and vacuum gage. A view of the gage board is shown Fig. 5.

In designing this plant, particular attention s been paid to simplifying the arrangement of e piping and the machinery. Several older ants have the piping placed below the pump om floor, causing trouble in case of repairs.

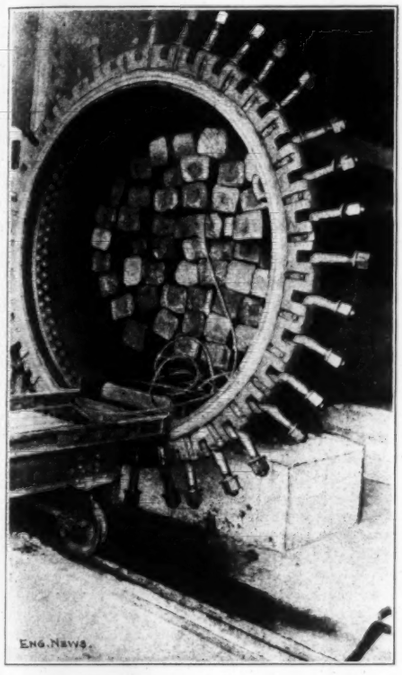

Fig. 4. Transfer Car for Connecting Cylinder Track with Yard Track.

(The cable is attached to the rear load, and the front end is attached to the drum of the bumper car for hauling out the train.)

In this new plant the piping is entirely above the floor and so arranged that it is easily accessible. The pump room and the cylinder room have the same floor level. All the service and pressure pumps, the air compressor and vacuum pump are placed at right angles to the treating cylinders, which arrangement gives easy access to all the machines.

The plant will operate principally the "full cell" process, but it is also arranged to operate the Rueping process if found necessary. This will be accomplished without the use of the additional overhead cylinder used in other plants. In operating the Rueping process, the treating cylinder is filled with compressed air immediately after the charge has been placed in the cylinder, and the oil is allowed to enter the cylinder against this air pressure. In plants using this process, it is customary to install an overhead cylinder for the purpose of filling the treating cylinder with oil under pressure. As the oil flows from the overhead cylinder into the treating cylinder, the air is displaced and passes into the former. In the new plant, this result will be accomplished by means of a pressure pump forcing the oil into the cylinder against the air pressure, while a relief valve on the top of the treating cylinder will allow the compressed air to escape.

Another special feature is that no ground tank will be used for discharging the oil from the treating cylinders. Compressed air will be used for blowing the oil from these cylinders directly to the overhead working tanks.

At this plant there will be treated a great deal of green piling, which is taken directly from the river and put into the cylinder for treatment. In order to know when the sap is out of the cylinder, there is a sap drum with gage glass, which shows the amount of sap at any time contained in the drum. Each cylinder will hold an average charge of about 800 ties, 7 × 9 ins. and 8½ ft. long, and will treat from three charges of partly seasoned ties to five charges of seasoned ties per 24 hours. This of course depends upon the material under treatment. When treating piling, the time of treatment will range between 10 to 15 hours, depending of course upon the process and upon the moisture in the piling. The approximate capacity of a plant of this size, handling material in the Atlantic coast, is 2,000,000 ties per year, and about 10,000,000 board feet of timber.

The creosote oil is secured at present on the Atlantic coast and is delivered at the company's wharves in tank steamers, at a temperature of about 130° F., depending upon the quality of oil. It is pumped by the ship's machinery through a 6-in. pipe line on the dock to the storage tanks, about 150 ft. from the main building.

Colored labor will be used, under the supervision of white foremen, but wherever possible the timber is handled by mechanical means, thus reducing labor.

The plant was built under the direction of Mr. J. I. Eppinger, Manager, and Mr. H. S. Valentine, Superintendent, of the Eppinger & Russell Co. The machinery, buildings and entire equipment were designed and installed by the Allis-Chalmers Co., of Milwaukee, Wis., under the supervision of the writer.

The Value of Reduced Weight in Street Cars.

For a couple of years past an increasing amount of attention has been given to ways of safely reducing the dead weight of electric cars, to secure a resultant reduction in the operating and fixed charges of the entire railroad system. A healthy reaction now seems to be manifested by car designers against the indiscriminate addition of heavy equipment in the shape of air operated gongs, sanders, and current-consuming accessories and against the careless multiplication of heavy features of ordinary equipment. Especial attention has been drawn to such a need of more careful designing and equipping, by the successful operation of cars where prevailing weights have been cut in half, to note an extreme case.

A discussion on the desirability of reducing car weights, forming a part of a report of the Equipment Committee of the American Street and Interurban Railway Engineering Association and written by Mr. M. V. Ayres, Assoc. Am. Inst. E. E., Electrical Engineer of the Boston & Worcester Street Ry., was printed in Engineering News, Dec. 2, 1909. Mr. Ayres has now contributed a further discussion of the subject to the "Electric Railway Journal," issue of April 16. As this article gives the most recent estimates of the amount of the savings to be effected by certain changes, the more important parts of the paper are reprinted below:

The publication in the "Electrical Railway Journal" of April 2 of the article relating to the new cars of the Boston & Northern and Old Colony Street Railways marks a very important step in the movement looking to the reduction of car weights. This movement is hardly more than two years old, and it has been fostered almost exclusively by a discussion of the savings to be expected, as indicated by theoretical considerations. Evidently in figuring the savings which will result to his company from the reduction of weight in the new cars the designer wished to be very conservative.

To arrive at a more correct view of the real value of the results attained in reducing the weights of these cars, I have made some calculations based on the following assumptions. I have assumed 44 cars, equipped with the higher gear ratio, to be the entire rolling stock of an interurban railway supplied with power from an alternating-current power plant with substations. I assume that at the dullest season of the year one-half the equipment, or 22 cars, would be required to run the load, averaging 270 miles per day each. For the time of best travel, I assume that all the cars would be in service and that the average condition for the year would be equivalent to a daily use of 33 cars for 270 miles each per day. I have made no attempt to correct the power consumption figures for difference in stops per mile, in view of the fact already known that the lighter cars seem actually to show a less frictional resistance. The power consumption therefore figures as follows:

If the cars were of the heavy 1907 type, the average daily load, at the cars, would be 33 × 270 × 3,320 = 29,600 KW.-hrs.

If the cars were of the light 1909 type, the average daily load, at the cars, would be 33 × 270 × 2,781 = 24,800 KW.-hrs.

If we assume the operating cost per KW.-hr. at the power house as 0.75 ct., the cost of direct-current at the substation will be about 1 ct., and at the car, allowing for trolley and feeder losses, about 1.15 cts. At this rate the annual cost of power for the heavy cars amounts to $124,200, and for the light cars $104,100.

The size of the necessary power station I figure as follows: For the heavy cars the average power requirement, at the cars, during time of heavy traffic when all cars are in use, is 2,190 KW. Increasing this by the ratio of 1.15 to .75 gives 3,360 KW. as the average demand at the power station under these conditions. Of course, the peaks of the load will be very much greater than this, but I have assumed that a power station of exactly 3,360 KW. rated capacity would be large enough, which it would be if everything was in perfect working order. At $125 per KW. this station would cost $420,000.

Figuring in the same way we find that the lighter cars would require a capacity of 2,818 KW. at a cost of $352,000. If we figure fixed charges, i. e., interest,

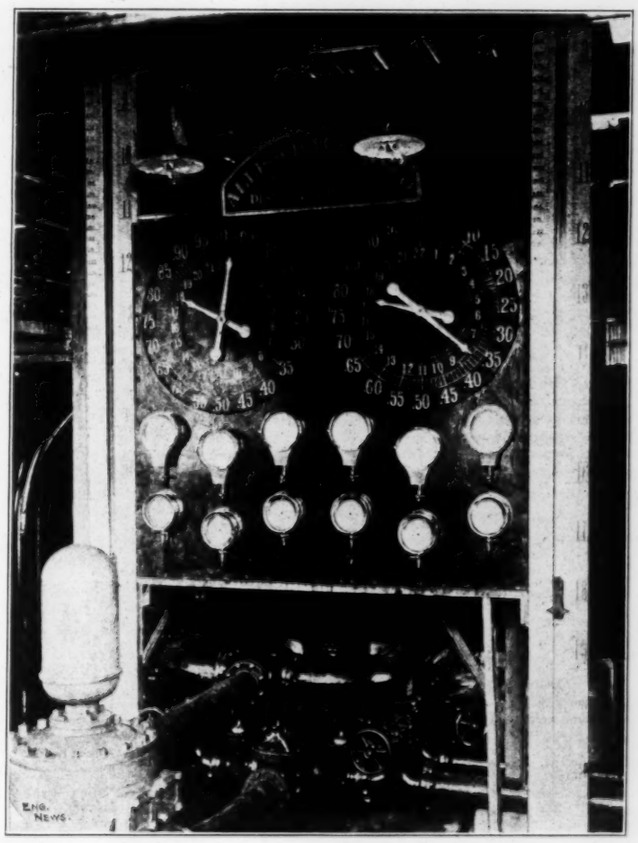

FIG. 5. GAGE BOARD FOR TANK DIALS AND RECORDING GAGES.

taxes, insurances and depreciation at 10%, we have $42,000 per annum chargeable to this item for the heavy cars, and $35,200 for the lighter cars. We may figure the substations as having 25% higher aggregate rating than the power station, and as costing $25 per KW. This gives the substation cost in the two cases as $105,000 and $88,000 with annual fixed charges of $10,500 and $8,800.

The cost of the transmission system will be greater for the heavy than for the light cars, but it is difficult to arrive at correct figures without making complicated assumptions as to the layout and equipment of the system. I, therefore, arrive at an estimate in the following way: The cost of the electric line construction of the Old Colony Street Ry. is given in the Massachusetts Railroad Commissioner's report for 1908 as $1,982,996, and the annual cost of power as $326,722. The transmission system cost 6.06 times the yearly cost of power. Figuring at a ratio of 6 to 1, the cost of this item for our assumed road using the heavy cars would be $745,000. It is not correct to assume that this would be reduced in proportion to the power demand, as a portion of the overhead work would be the same in either case. Our power consumption is reduced by the light cars 16%. It would seem fair to assume that the cost of the transmission system would be reduced 8%, to $685,000. Assuming fixed charges on this at 7½%, we have annual charges of $55,900 if heavy cars are used and $51,400 if light.

There can be no doubt that repairs of electrical equipment will be less with light cars, because the average load is 16% less on the same motors. It seems fair to assume an 8% reduction in repair costs. Again referring to the Railroad Commissioner's report, we find that repairs to electrical equipment cost $100,761 with a car mileage of 10,090,000. This is almost exactly 1 ct. per mile. On our assumed road, the repairs to the heavy cars at 1 ct. per mile would amount to $32,000. For the light cars, at 8% less, this would be $29,000. There is not the slightest doubt in my mind that other car repairs, not electrical, will be much less for the light than for the heavy cars. Brake-shoe, wheel and bearing wear, for instance, should be reduced at least proportionately to the weight. I believe the lighter design is also inherently the stronger, but for lack of data on which to base an estimate I have refrained from assuming any saving in car repairs except that for electrical repairs above indicated.

There can be no doubt that the use of lighter cars would materially reduce track repairs, but for lack of data I make no attempt to estimate this saving. The costs above estimated are shown below:

	Heavy car.	Light car.
Cost of power	$124,200	$104,100
Fixed charges, power station	42,000	35,200
Fixed charges, substation	10,500	8,800
Fixed charges, transmission	55,900	51,400
Repair cars	32,500	29,900
Totals	$265,100	$229,400

Difference $35,700.

I believe that my method of calculating is the correct one, even although the savings of fixed charges and labor costs do not at once become evident. The actual result of equipping an entire system operating under the conditions indicated with one kind of equipment or the other would be to show an annual saving approximately equal to that indicated, of $800 per car in favor of the lighter car. It is, therefore, only fair to credit the few cars actually in use with their full share of the saving ultimately to be achieved if the policy which led to their adoption is followed to its logical conclusion.

In my paper, "Car Weights as Affecting Operating Costs,"* which formed part of the report of the equipment committee of the American Street & Interurban Railway Engineering Association at Denver last October, I attempted an analysis of the probable savings due to a reduction of car weights. In the following table I give a comparison of the savings per mile per ton of weight reduction, as taken from my Denver paper, and as derived from the above calculations for the 44 cars under the condition assumed.

	Saving, Cts. per ton mile— Denver estimate.	Old Colony car.
Power consumption	$0.1000	$0.1870
Cost of car repairs	0.0700	0.0242
Cost of track repairs	0.0260	....
Fixed charges, power plant, including substation	0.0500	0.0791
Fixed charges, distribution system	0.0200	0.0419
Totals	$0.2400	$0.3322

The wide divergence between these two estimates is readily explained. It is principally due to a difference in power consumption. The Old Colony tests show a saving of 539 watt-hours per car-mile due to a reduction of weight of 3,303 tons, or a reduction of power of 163 watt-hours per ton-mile. My Denver estimate was 100 watt-hours per ton-mile, but I specifically stated that this figure would vary between wide limits, according to conditions of operation, and the figure I chose was intended to apply to more moderate conditions of operation than evidently obtained on the Brockton-New Bedford route. Part of the increase in the power figure is due to the fact that in my present estimate I assume a somewhat greater loss in transmission than in the earlier estimate. I think the larger figure is more nearly correct. The increase in fixed charges on power plant and distribution systems is due directly to the increase in power. The difference in car repairs is due principally to the fact that in the present estimate I have made no allowance for reduced repairs to mechanical equipment, and have assumed a reduction in electrical repairs proportional to only one-half the weight, whereas in the former estimate I assumed a reduction in all items of car repairs directly proportional to the reductions in weight.

The saving in cents per pound per year seems to be the figure which is most convenient for practical use, and the one which makes the strongest appeal to the imagination, although it is a figure which must necessarily vary with different conditions of operation. Some engineers have assumed a value for this as low as 2 cts. The value most commonly used appears to be 5 cts. The estimate made in my Denver paper as a fair average was 7½ cts. The value corresponding to the figures above given for the Old Colony cars is 12.6 cts. The saving estimated for these cars by the designer is only 4.82 cts. for the interurban service, and his figures if corrected for the reduced mileage of my estimate would be reduced to 3.62 cts.

All of this testimony shows that the saving to be attributed to a reduction of car weights varies greatly with the conditions and still more with the point of view. However, for reasons already set forth, it appears clear that in the long run all of the factors of saving which I have discussed above will come into effect, and the net value of the weight reduction will approximate the largest figures rather than any of the smaller ones.

*See Engineering News, Dec. 2, 1909.

Limitations of Efficiency in Engineering Education.*

By GEORGE FILLMORE SWAIN, LL. D.†

Our colleges, universities and technical schools are at the present time the subject of serious criticism at the hands of many writers, some of them high in authority in educational matters, some of them outsiders with no teaching or experience, who judge of the work of the schools by the men that are turned out. Even the presidents of some of our educational institutions, if they have been correctly reported, admit that much of the development of the last few decades has been, if not in the wrong direction, at least incomplete or unsymmetrical, and that important modifications need to be made in regard to methods of instruction and administration, as well as in matters of general educational policy. Critics outside the teaching profession, joining in the complaint, have pointed out what they consider serious faults, and have indicated how, in their opinion, our colleges should be reorganized.

While most of this criticism has been directed against the colleges, the engineering schools have come in for their share. Engineers of eminence, like Mr. F. W. Taylor, and employers of engineers, like Mr. Crane, have told us that the engineering graduate, when he leaves the technical school or the university, is of little or no use to his employers—at least until he has been seasoned by several years of experience in contact with the hard world—with the solid facts of life.

Let me invite your attention for a few moments to a consideration of the questions what the engineering graduate might be and ought to be when he leaves the school, what he too often is, and what some of the difficulties are which prevent the attainment of the ideal; in other words, let us consider some of the limitations of efficiency in engineering education.

Let me first admit that a long experience in teaching has convinced me that there is much truth in the criticisms which have been made. I fully believe, however, that they have been often exaggerated, and, moreover, that many of the defects that have been pointed out are capable of remedy.

When our technical schools were new, say forty or fifty years ago, the value of a scientific training was not appreciated by manufacturers or even by members of the engineering profession itself. The majority of engineers had not had the advantages of a thorough education, and indeed, it had not been fully realized that engineering was a science. It was considered a branch of the building art, and its practice was largely empirical. Consequently, engineering graduates often had difficulty in obtaining positions, and their scientific acquirements were considered to be of little use; the young graduate were looked upon as theorists, and as inferior to the practical men who had gained their knowledge by experience. A sharp contrast was drawn between theory and practice, as though the two were incompatible; and the practical man, whether engineer or employer, scoffed at the theorist, often only too justly.

All this, however, rapidly changed; the schools soon realized the fact that they could not make a man an engineer, and that they should confine their attention mainly to giving him the foundation of scientific principles on which he could build, and which would enable him, as he should gain experience, to understand and coördinate what he had learned, and thus to practice his profession in a truly scientific way. The teaching of engineering instead of being done by mathematicians, or men with no practical experience in the things they were teaching, began to come into the hands of men who were practical engineers as well as scientists, and who knew the importance of teaching mathematics and mechanics in such a way that they could be used as tools instead of regarded as abstractions.

Employers engaged in business in which the applied scientist could legitimately be useful, on the other hand, soon learned that many of these young men could do things which were entirely beyond the power of the unschooled man, even with years of experience. Visiting one of our engineering schools some twenty years ago for the first time, one of these employers was quite surprised at what he saw, and at the work which had been done by the students. Upon leaving the president of the institution, he said that he had been much impressed, and thought he would take a number of men of the senior class as soon as they were graduated, to which the president replied that he would not take these men, because they all had been already spoken for.

This change is still going on. The enormous development of engineering, and the growing recognition of the fact that a university or college, instead of giving a man so-called culture only, should train him definitely for active work in the world, led to the corresponding development of engineering departments. And, certainly, of the work of the world, a very large part is dependent upon applied science, and the engineering department of a university should be one of its strongest and largest departments. Teaching which is concrete and practical, yet thoroughly scientific, is increasing, and graduates more and more capable of immediate usefulness, and at the same time better trained, are being turned out year after year.

Mr. Taylor sweepingly declares that the manufacturers of this country do not want anything to do with young men just coming from technical schools,—that they would rather not have them, and find them of little use in their business. This, I think, is a great exaggeration. Mr. Taylor has had a long experience, and an opportunity to come in contact with large numbers of manufacturers; nevertheless, I doubt the accuracy of this statement that the graduate is not wanted. Certainly it is not true, according to my experience, in the case of graduates in civil engineering. The railroad companies of this country, who are perhaps the largest employers of engineering graduates, desire all they can get, and some of them make it a rule to recruit their forces, if possible, entirely with such men. Our structural companies prefer them—in fact, desire no others if they can get technical graduates personally recommended by their teachers. In hydraulic engineering, sanitary engineering, and all other branches of the civil engineering profession, if we are to judge by the demand for these men, they prove themselves in-

*An address delivered at the exercises at the opening of the new Carnegie Engineering Building of Union University, Schenectady, N. Y.

†Gordon McKay Professor of Civil Engineering in Harvard University.

ediately serviceable, and in the vast majority cases they advance rapidly enough to demonrate the fact that their technical education has en of great advantage to them.

A similar condition seems to exist with refernce to mining and electrical engineering. I am ld that your great electrical company recruits s engineering staff, if possible, entirely with chnical graduates. As for mechanical engiering, I am sure that the demand for such raduates from at least some of our schools is r above the supply. If, as Mr. Taylor affirms, he manufacturers of the country do not find hese men useful, I for one am sorry for the anufacturers. I regret that they are so far ehind the procession. It the statement is true, erhaps that is the reason why those manufacrers consider that they need so much protecion against the competition of foreign countries, ike France and Germany, where the technically rained man is unquestionably fully appreciated, nd where technical schools have been longest stablished.

President Draper finely expresses the value of a higher education when he says: "With an independent, sane, balanced character, having the elements of success anyway, the advantage of a college training cannot be over-estimated." This is even more true with reference to a professional education.

The young man from a technical school should have passed through four years of discipline—mental, moral and physical.

His physical discipline should have enabled him to restrain his appetites, to govern his passions, to make his hand and eye quickly responsive to his will, to be a master of himself. His step should be firm, his carriage erect, his muscles hard, his body capable of enduring much physical fatigue.

His moral education should have made him realize the ethical principles which should govern a man's acts in this world and regulate his conduct toward his fellow men. He should have learned to be truthful and honest; thoughtful and forgiving toward others; stern and unforgiving toward himself. He should have learned the supreme lesson of disinterestedness, and should have gained the power of working for the sake of the work and its results rather than for his own selfish purposes; he should have learned to look down with something like contempt upon the petty things of this world and to realize that they amount to little compared with the perfecting of his own character.

His mental training should have enabled him to estimate justly his own powers and to know how to use them. He should have had an opportunity to "find himself" and to study his own tendencies and innate talents; and he should, therefore, be in a position to direct himself toward the field of human endeavor in which those qualities will enable him to do the best work. He should have learned thoroughly the fundamental principles upon which are based the branch of engineering which he is to follow, and the power to apply them intelligently and correctly. He should be modest, realizing how little he knows and how little experience he possesses, yet self-reliant, feeling that he has mastered the fundamental principles which he is to apply in the world of action. He should be possessed of mental courage, having been taught to study a subject with no preconceived ideas or prejudices, but solely intent on reaching the truth. He should be able to observe accurately, and to reason logically from premises gained by observation or otherwise.

The average engineering graduate, and especially the college graduate, unfortunately falls far short of this ideal, although it is measurably within the reach of all. The causes of his failure are partly due to the student himself, partly to his parents, partly to the college.

Let me call your attention to some of his shortcomings, the reasons for them, and the possible remedies for them, as they appear to me.

Physical Training.

In the first place we are too apt to understand by the term "education" simply mental education; moral and physical education or training do not receive the proper degree of attention. In some of our colleges and technical schools no effort whatever is made to give physical training, to develop a sound physique, to discover and point out physical defects, and to apply some systematic corrective. Athletics, as at present cultivated, affect only the few men who, voluntarily or by solicitation, engage in them. The great mass of students take no part in them, except to look on and applaud when the home team wins. In my opinion, every college and technical school should insist on some physical training for every one of its students who is not physically incapable of it. A man may, by reason of some hereditary weakness, or accident, be obliged to forever renounce the hope of being physically strong. That is his misfortune, and it may exclude him from the possibility of practicing certain branches of the profession; but if he has the other qualities which lead to success, he need have no misgivings. In such case, he should, by cultivating temperance in all things, and by careful observance of the rule of personal hygiene, preserve to himself all the physical vigor possible. The man who is physically most robust may not last the longest, or do the best work in the world. Success depends, not upon one quality, but upon the proper combination, and physical strength is perhaps the quality which may be most easily dispensed with. Probably this is the reason why it has been neglected.

Nevertheless, physical training should be insisted upon. It should be preceded by a thorough examination of each man, by an expert who should prescribe what exercises will best strengthen the weak spots and develop the physical endurance which is likely to be such a valuable asset to an engineer. Every student would also gain much were he required to take a course in physiology, so that he may be made acquainted with the laws of personal hygiene, and know how to take care of himself and to regulate his diet. Physical training is perhaps of more importance to the engineer than to members of any other profession, for the engineer is essentially an out-of-door man, or is likely to be one, and his capacity to endure fatigue and hardship if called upon, may be an essential element in his success. It is hoped that such a course would lead the student to abstain from all but the most sparing use of tobacco and alcoholic beverages. He will be fortunate if it leads him to renounce them entirely.

Moral Education.

In the second place, moral education is, as a rule, much neglected. By many teachers or even institutions it appears to be considered that this should be left entirely to the home and the church—that the school should simply train the mind. This seems to me a fundamental mistake. It is sometimes said that the salvation of a democratic country like this lies in a widely diffused and high standard of education. It would seem clear, however, that the kind of education upon which our salvation will depend is moral education rather than mental education.

Half knowledge is, proverbially, a dangerous thing; and a smattering of economics, history, language, science, or what not, such as most students acquire, or even a thorough knowledge, will not enable a man to perform properly the duties of a citizen, if he has failed to become imbued with the moral law, and to realize the supreme importance of his duties toward his neighbor, and the necessity of playing the game of life fairly. Dishonesty is not confined to the poor or the ignorant; it is doubtful if it is more frequent among them, on the whole, notwithstanding the many and varied temptations which poverty necessarily brings.

Not only, therefore, should the college or technical school require some training in subjects which will imbue students with an appreciation of the importance of the moral law from the professional as well as from the personal point of view, but every teacher should consider himself, so far as consistent, a moral teacher and should seize the opportunities, which will often come, and enforce a moral lesson.

Mental Education.

But coming to what is generally considered as education, that is, mental education, most graduates of our colleges and technical schools are no doubt far removed from the ideal which has been sketched. Not only have many of them failed to master thoroughly the fundamental principles which they are supposed to have learned, but they are not able to observe correctly or to reason logically; and they have, furthermore, so little realization of their own defects and are possessed of so little modesty, that they go out into the world with an overweening and unjustified conceit, with an unwillingness to begin at the bottom and learn a business thoroughly, and with an inability to do cheerfully, uncomplainingly, persistently, and enthusiastically, the routine work or drudgery of which the greater part of the world's work consists, and in the proper doing of which the highest discipline lies. They are uneasy if they do not quickly receive promotion; they are impatient of the self-taught, unschooled men who work by their sides, although these men may be their superiors, and possessed of far more common sense than they; and because they have wasted a great part of the time which has been devoted to their education—perhaps some of it in riotous living—they are unable to appreciate the things which the untaught man may have learned and which they have still to discover.

Measuring Efficiency.

The engineer, in estimating the performance of a machine, measures its value by what is termed its "mechanical efficiency." This is the ratio of the effective work done by the machine to the energy which is put into it. The higher the efficiency the better the machine. The efficiency of a business may be measured somewhat in the same manner; in this case best, perhaps, by the ratio of net earnings to the total investment, provided that the investment has been properly expended. Of course, one business cannot in this way be compared directly with another on the same basis, for in one sort of business the possible net earnings may be far smaller compared with the total investment than is the case in another kind of business. Nevertheless, there is a sort of measure, even if rough compared with the mechanical one. That measure is expressed in dollars. Since dollars are desirable or necessary to those who have invested in the concern, if a low efficiency is shown—lower than should reasonably be expected, or lower than is shown in similar concerns similarly situated—there will probably be a demand for a change of management.

I have often asked myself the question: what is the efficiency of education? Unfortunately, however, there is no measure for that efficiency. The manufacturer takes the raw material out of which he manufactures his product—a log of wood, for example;—he pays for this raw material and for the labor expended upon it, in money; fashions it into the form desired, and sells it for other money. The efficiency of the entire process can be measured, if not with exactness, at least approximately.

In education the raw material is the student. Labor, enthusiasm and money are expended upon him. The product is the improvement which results to him mentally, morally and physically, and this is incapable of quantitative estimation. Nevertheless, I have for a long time believed that if it could be estimated it would be found that the efficiency of education is in general very small; that the result in improved physical strength, morality, power of thought, is but a small fraction of the energy expended.

But even if the efficiency is small, it does not follow that the work is not worth doing, or not done well. The light given out by the electric lamp represents less than 1% of the theoretical energy in the coal, yet it does not follow that electrical lighting is not worth while. It depends upon the intrinsic value of the product. So, in education, to inspire and discipline even a few young men may be worth far more than all the effort expended upon them and others, for it means keeping alive the torch of learning, and feeding the flame of research, so that the treasures of

thought and the methods of scientific investigation may be transmitted to those who shall follow us, and so stimulate intellectual progress in the years to come.

It is also essential, before judging of the real value of higher education, to estimate the necessary limitations of efficiency, to consider the inevitable losses and sources of waste, and thus to refer the final product, not to a purely theoretical and impossible maximum, but to a practically attainable one: in other words, to consider the reasons for the observed defects, and to ascertain to what extent they are practically remediable.

The reasons for these defects seem to arise from four main sources: 1, the student; 2, the parent; 3, the teacher; 4, the administration.

The Defects Due to the Student.

The main source of the inefficiency of education and the principal justification for the criticisms which have been made upon its results, seem to me to lie in the students themselves. They go to the college or technical school, where they find afforded them abundant opportunities; but many of them are lacking in will, and are not able to avail themselves of them.

While the manufacturer, by the application of external power, molds his raw material into the desired form, education cannot so fashion its raw material. The fundamental difficulty with education seems to me to be the fact that the only culture or training which does a man any good is *self-culture*,—that which he imposes upon himself. The teacher may present his subject with perfect clearness, he may give examples to illustrate it, he may impress upon his students emphatically the necessity of doing certain things, he may tell them what to do, and what not to do, what mental and moral habits they must cultivate and which they must shun, but he cannot make them follow his injunctions. Many of them will be found to lack the interest and the will to see the necessity for self-exertion, and to impose upon themselves the moral and mental discipline without which success in their work will not be attained.

This may not be due to any lack of good intention; they may be earnest enough, they may work long hours, but many of them will not work in the right way, no matter how often they are shown, nor will they take the trouble to learn the methods of logical thinking. They are lacking in will. They do not realize that their success will depend more upon their wills than upon their brains.

Dr. W. H. Thomson, in his most interesting book, "Brain and Personality," says "we can make our own brains, so far as special mental functions or aptitudes are concerned, if only we have will strong enough to take the trouble." When to this is added that the will, like any other function of the human being, can be trained, and its strength increased, we have the fundamental principles of self-culture, which do not begin to be appreciated as yet, either by students or by teachers.

If the attempt is made to force the student into a rigid system to control his every movement, he may be to some extent disciplined, but his interest, his initiative, his spontaneity, and his power of self-control, will not be developed. It is the old question whether a young man can be trained to self-control by keeping him in subjection,—whether he can be trained to govern himself except by letting him try—which seems to have been decided, and, on the whole, wisely decided, in the negative.

A certain amount of military training, for instance, is no doubt of advantage to every one; it develops obedience, promptness, and other similar qualities; but it does not train the will, nor teach self-command, nor stimulate the highest faculties. Soldiers are not noted for self-control as compared with those who have not been exposed to military discipline. Indeed, the moment the usual pressure is relaxed they are only too apt to show the absence of that quality; nor have many advances in learning or in the arts come from military men. At some time in a young man's life, he must be thrown upon his own responsibilities, and it would scarcely seem wise to defer that point until the end of the college course.

If he is not ready to learn that lesson in college by the time he is 17 or 18 years old, there is a strong probability that he ought not to be sent to college at all, but that he should be made to learn the lesson, if possible, in the harder school of the outside world, and let such a man be thankful if it prove a school of hard knocks.

Right here it may be remarked that much of the criticism of our schools would not be made if it were recognized that the trouble is not alone what they do or what they leave undone, but that the right boys are not always sent to college. There are multitudes of young men there who never ought to have been sent—who are not qualified to take advantage of the kind of training which the college really ought to give, and which is the very best kind for those who can avail themselves of it; whose will and whose natural ability will not justify a higher education; one thousand dollar men who are being given a five thousand dollar education. And there are also multitudes of young men who would take advantage of such opportunities, who cannot afford to do so.

One of the most hopeful signs in our educational progress, to my mind, is the increasing opportunity for deserving young men to get all the education which they are good for, provided it does not give them more than they are good for.

Our schools, from the bottom up, should be better designed to prepare men for their proper vocations in life—industrial, farming, or professional—to guide each man better into his proper field, and to prevent him from entering into fields for which he is not suited. It is far better to be a good mechanic than a poor engineer or lawyer, and there are just as many opportunities for a good mechanic to be advanced to responsible administrative positions as for the poor engineer. One of the main problems of education would seem to be to guide each man into his proper place so far as possible.

No better proof of what has been said is needed than the fact that so many men who have attained success despite the lack of educational advantages, send their own sons to college, realizing how much they themselves might have gained from such an opportunity. Unfortunately, too many such parents fail to realize how much of their own success has been due to the fact that they were obliged to overcome difficulties; they do not train their sons to do the same; they give them too much money to spend, and thus they send them to college unprepared to utilize the advantages presented.

We talk much of opportunity. We do not sufficiently realize that necessity is, on the whole, a greater element in success, and a better friend, than opportunity.

There are many other difficulties which arise with the student, but I need not dwell upon them. Many students are "sent" to college; they do not go, they are sent. They take little interest in their work; their main object is to get through. When they study a subject, their minds are fixed upon the mark which they are to receive, on the examination which they are to pass. Instead of being disinterestedly concerned with getting the most they can out of the opportunity which the course presents, they will procure old examination papers and a tutor, and get themselves coached so that they may be able to scrape through, after which they will promptly dismiss the subject from their minds. A long experience in teaching has convinced me that no amount of effort by the teacher will have much effect in the case of some students in inducing them to take a different attitude.

The fundamental difficulty, then, with the student, is that discipline and correct thinking are not things which can be imposed upon him from without, but things which he must acquire for himself and which he can only learn to acquire for himself by being given the opportunity. To use a favorite illustration, the school is not a restaurant where a man goes to be filled up, but it is a gymnasium where he finds the apparatu which, if used as he is shown, will develop hi as he ought to be developed.

The Defects Due to the Parents.

Right here is where the parent must bear som share of the responsibility for the lack of effi ciency of education. Time will not permit of a elaboration of this branch of the subject. It wi suffice to say that the utmost efforts of th teacher will be of little avail unless with th cordial cooperation and support of the home in fluences.

Mental discipline at college cannot win against social and financial dissipation at home, and al the efforts of the teacher to enforce the import ance of self-culture and training of the will wil come to naught if the parents think, as many do that the son is sent to school to buy an educa tion as he buys a suit of clothes. To a parent who was finding fault with a teacher for the slow progress of his son, the teacher replied that he could not put brains and will into the boy as well as instruction.

One great difficulty with the student of engineering arises from his lack of knowledge of the practical applications of the subjects which he is studying, and further, from the failure to realize the necessity for a higher education and the fact that there are many men in what might be called the lower ranks of life who are just as bright as he is. If the student from a wealthy family could be made to realize that the son of the blacksmith around the corner had just as good a brain as he, it would not only make him more democratic and a better citizen, with more respect for the opinions of others, but it would also make him realize that if he wishes to win a high place in engineering, it will be necessary for him to get something which the blacksmith's son does not have and cannot easily get. Experience would be open to both of them, but education might be open to only one.

The necessity of earning his living, the realization that there are plenty of young men in overalls, with as good native ability as he, are two powerful incentives which will make a young man appreciate the value of an education. In order to develop this appreciation, students of engineering should gain some practice in the workshop or in the field; and they should make if possible it a rule from the time they enter the college—or better, from the time they enter the high school—to spend their vacations in some occupation in which they will be earning their own way.

Defects in the Instruction.

But while the main difficulty, in my opinion, lies with the student himself, and with his parents, there is undoubtedly, in most cases, just room for criticism of the teaching in our schools. Among the defects commonly found, a few may be mentioned:

1. There is too great prevalence of courses which are information courses only, and a lack of realization on the part of the teacher that his main object should be to teach the student to think. We may well reflect upon Locke's statement that the objects of education in their relative rank are as follows:

1. Virtue.
2. Wisdom.
3. Good breeding.
4. Learning.

Learing—to which we almost confine our attention—placed last. And even with reference to learning, we often misplace the emphasis. The student must of course be taught many facts, but the main emphasis should be laid upon the use which is made of those facts. Logical thinking is the main object. If the student gains this, he can reason upon new facts and in any subject; if he does not, he simply uses in a rule-of-thumb way the few specific facts which he has learned.

2. There seems to me to be an undue use of the lecture system. This is a very serious evil, in my opinion, and unfortunately seems to be increasing and to be extending even into the secondary schools. A young man may be interested and may gain some information by listening to a

lecture, but he will not gain much mental training. The use of lectures without text books seems particularly futile, except, perhaps, in some special subjects. The student should have a text book which he is required to study. The exercises in the class room should consist in finding out whether he has studied it and mastered it, and if not, why not; and a certain portion of time should be taken in enlarging and explaining the subject itself.

A quiz or a recitation enables the teacher to discover the mental defects of his pupils and to point them out. Such a process is indeed sometimes discouraging to the student. He would prefer to remain in blissful ignorance of his defects, and to go through his courses believing that he understands them and is able to think; but a knowledge of one's defects is the beginning of wisdom. We all, of course, have defects, but we never remedy them unless we realize that we have them and what they are. The student, if he takes the proper attitude of mind, should realize that one of the main things that he goes to college for is to have his defects pointed out to him, and he should not thereby be discouraged, but should have the will to impose upon himself a discipline which will correct them.

Grote, in his history of Greece, makes the following statement with reference to the teaching of Socrates:

> The Socratic dialectics, clearing away from the mind its fancied knowledge and laying bare the real ignorance, produced an immediate effect like the touch of the torpedo. The newly created consciousness of ignorance was alike unexpected, painful and humiliating—a season of doubt and discomfort, yet combined with an internal working and yearning after truth, never before experienced. Such intellectual quickening, which could never commence until the mind had been disabused of its original illusion of false knowledge, was considered by Socrates not merely as the index and precursor, but as the indispensable condition of future progress.

Can we improve upon this principle today? Do we sufficiently appreciate and use it?

Until the lecture system is largely done away with, or reduced to an absolute minimum, many elaborate courses will continue to be accompanied with little result. Of course there is a difference between subjects; some require experimental demonstration, and in them lectures may properly form a considerable portion of the course, while others should be conducted almost entirely with the use of the text book and the recitation. The point is, that except for thoroughly disciplined students, who already know how to think and how to govern themselves, lectures should, in my opinion, be reduced in each case to the minimum.

3. Another fault, which seems very common, is that no attention is paid in many institutions to teaching the students *how to study*. Young men animated with the best intentions, work *hard* but *ineffectively* in the endeavor to master the subjects presented to them. It is not sufficiently realized that hard work is not what is needed, and will never bring a man success unless it is also effective work. A man should train himself to work like a well oiled machine, accomplishing a result easily, quickly, and without friction. Some instruction with reference to the proper methods of study would seem to be essential, yet I have rarely known of such instruction being given.

4. Equally striking is the fact that in many institutions no attempt is made to teach methods of reasoning in general, except in so far as it is done in connection with the special courses. In the Middle Ages logic occupied an important part in higher training, and it was generally taught in universities up to within a few decades. Since that time it seems to have largely disappeared, and in some of our higher schools little or no attempt is now made, except, as already stated, in connection with individual courses, to teach the student the general rules of correct reasoning, in other words, the principles of logic.

It is true that the study of formal logic was carried entirely too far, applied to improper purposes, and, in a word, entirely misapplied and exaggerated. It would be absurd to revive in their old form the dialectics of the schoolmen. But that is no reason why logic should be neglected; and while the capable instructor may teach much logic in a course not specifically devoted to that subject, the fact remains that many, if not most, of the graduates of our technical schools are not capable of independent logical reasoning, even on scientific subjects.

It is, I think, not sufficiently recognized, even by teachers, that there are certain methods of logical thinking, certain fallacies which must be guarded against, certain modes of detecting these fallacies, and certain tests of correct results. Most students seem to think that reasoning is a natural function of the mind just as walking is of the legs; but even if it be true that "the brain secretes thought as the liver secretes bile" it certainly is not true that it naturally secretes *logical* thought. Though a man have a mind, it does not follow that he can think correctly. He must have the logical principles upon which correct thinking depends, and there are many reasons for believing that he will learn them best by consciously studying the subject of logic rather than by taking it as the by-product of other courses.

Locke, in the preface of his most valuable little book on "The Conduct of the Understanding," makes the following remark:

> I cannot think any parent or instructor justified in neglecting to put this little treatise in the hands of a boy about the time when the reasoning faculties become developed. It will give him a sober and serious, not flippant or self-conceited, independency of thinking; and, while it teaches how to distrust ourselves and to watch those prejudices which necessarily grow up from one cause or another, will inspire a reasonable confidence in what he has well considered, by taking off a little of that deference to authority which is the more to be regretted in its excess that, like its cousin-german, party-spirit, it is frequently united to loyalty of heart and the generous enthusiasm of youth.

I have talked with many students from many universities, technical schools and preparatory schools, and the replies received from most of them indicate that during their whole preparatory and college course they have never been given any instruction corresponding to that contained in this book. The result is that fallacies which any mind trained in logic would be able to observe, pass the minds of these men without discovery.

I am aware of the fact that courses in logic are offered in many of our universities, and taken by a considerable number of students in the aggregate, but I am also aware of the fact that in many institutions, and particularly in technical schools, no such courses whatever are offered; and furthermore, I do not know of a single institution in which such a course is required.

I am further aware of the fact that no amount of instruction would ever result in making some men think logically.

I make a plea for the restoration of logic in some specific form as a required subject in the curriculum of every higher institution of learning.

The study of logic, however, must, of course, be coordinated with other studies, and with the training of the powers of observation and mental discrimination as to the facts; for unless we make sure of the facts which constitute our premises, the use of the syllogism may only result in multiplying error instead of disclosing truth.

5. A further difficulty in education arises from the difficulty of obtaining good teachers, and in some cases from the practical impossibility of getting rid of poor ones. A large part of this difficulty is no doubt due to the enormous increase, within the past few decades, in the number of teachers required, corresponding to the remarkable growth of high schools and the enormous expansion of colleges and universities. For instance, in 1860 the number of high schools in the United States was 44; in 1870, 160; in 1880, 800; in 1890, 2,526, and 1900, 6,005. In 1908 the number of teachers in our higher schools, including colleges, was about seven times what it was in 1870. There appears to be a real difficulty in obtaining competent teachers for high schools and colleges, particularly in view of the fact that the remuneration offered in this profession is much less than that which a capable man may expect to obtain in business or in one of the other professions.

If a man is not possessed of independent means, and if he wishes to marry and bring up a family comfortably, he will find the attractions of the teaching profession from this point of view very small. This is abundantly shown by the statistics recently given in an article in "Science" discussing the status of the assistant professor. The result is that many men probably go into teaching because they would not succeed in the world outside; and in technical subjects such men may often fail to give to the students the qualities necessary for success in the world.

Furthermore, in many of our institutions there seems to be little or no attempt made to appoint teachers with reference to their teaching ability, or to subsequently exercise any oversight over the conduct of their classes or the methods which they use. A man is appointed to a teaching position and is allowed to conduct his classes as he pleases. This is, of course, more true in some institutions than in others, but I believe that at least the criticism is well founded that not enough care is taken by those in charge of our educational institutions or of the departments thereof, to see that really effective teaching is done.

On the other hand, the teacher may make things too plain to the students. When the student meets a difficulty, the teacher may be either so anxious to show that he understands how to solve it; or, in the kindness of his heart he may be so anxious to help the student, that he lifts him bodily over the difficulty without making him exercise his own powers at all. The only way that we become strong is by overcoming difficulties; we do not gain strength so long as our difficulties are overcome for us by others; yet this is too often done in teaching.

Or, it may be that the teacher is entirely unable to see the real difficulty in the mind of the pupil, and therefore, while he may try to explain it he may only succeed in throwing more obscurity upon the subject.

I believe it would be desirable if the teachers in our institutions would more often discuss among themselves—perhaps at stated meetings—the methods of teaching to be used; perhaps with the cooperation and criticism of some of the best students or recent graduates. It stands to reason, of course, that every teacher ought to have had some training in pedagogics; yet I believe that such training is rare in the teachers in our engineering schools, and it is perhaps too much to expect it. But it is not too much to expect that if they begin the career of teachers they should then devote some time to the study of the subject, or submit for a time, to careful oversight of their work. Unfortunately, academic freedom is too often interpreted to mean, not simply the freedom of students to do as they please, but the freedom of teachers to do the same entirely without criticism from any one; and some teachers who may be doing ineffective work would probably strongly resent any suggestion that they should change their methods. The result of this condition is that, in many institutions, courses may be found which have been given for years, which the best students and alumni would admit to be entirely unprofitable, and which, perhaps, the authorities of the institution know to be ineffective; and yet, with our present methods of university organization, there seems to be no way of remedying such a situation, any attempt to remedy it being considered either as arbitrary interference or a violation of the so-called educational democracy under which every man is allowed to do as he pleases.

Criticism of educational methods should, of course, always be kindly and it should also recognize the inherent difference between the conduct of education and the conduct of a business enterprise, that in the former individualism should be encouraged rather than suppressed. In corporation management it may be desirable or necessary to reduce the work of the different departments to a rigid routine; while in education such a proceeding would be most unfortunate.

Nevertheless, individualism should not be allowed to override the fundamental principles of pedagogics, nor carried beyond reasonable limits. It must not be forgotten that the teacher is in a position where he can do not only much good, but much harm, and care should be taken that the latter is not the result of his efforts.

It is in regard to this phase of the question that the difference between the conduct of an institution of learning and of a business is perhaps most marked. In the latter there is a concentration of responsibility and a supervision of methods. A new president may entirely reorganize a railroad system, may cause the accounts to be kept in an entirely new manner, may readjust the relations of the different departments, may require the head of any department to have his work done in an entirely different way from that in which it had been done before, and all this without offense to any one.

Such a method of procedure, even if necessary, would be likely to be considered nothing short of tyranny in an educational institution, and the limitations to acts of this kind have already been suggested; yet there should be some happy medium, some way by which the relations of teachers to each other, to the head of departments, and to the president, could be easily adjusted and without friction, in such a way that radical innovations might be brought about.

If a new university president has individual ideas, is there any good reason why he should not be enabled to carry them out, and why he should not be loyally supported in doing so, by trustees and faculty, even though his ideas are contrary to individual opinion? Until this can be done, until responsibility can be concentrated, and until means and methods are under practical control of the persons so made responsible, there will be no hope of obtaining the highest efficiency in education.

With reference to this matter I do not know of any more forceful statement than that made by Andrew S. Draper in his remarkably suggestive book on "American Education," in which he says:

> The very life of the institution depends upon eliminating weak and unproductive teachers, and upon reinforcing the teaching body with the very best in the world. Unless there is scientific aggressiveness in the search of new knowledge some very serious claims must be abandoned and some attitudes completely changed. No board ever got rid of a teacher or an investigator—no matter how weak or absurd—except for immorality known to the public. The reason why a board cannot deal with such a matter is the lack of individual confidence about what to do and of individual responsibility for doing nothing. But, with three or four hundred in the faculty, the need of attention to this vital matter is always present. No board knows where new men of first quality are to be found; no board can conduct the negotiations for them, or fit them into an harmonious and effective whole. The man who is fitted for this great burden, and who puts his conscience up against his responsibility, can hardly be expected to tolerate the opposition of an unsubstantial sentiment which would protect a teacher at all hazards, or the more subtle combination of selfish influences which puts personal over and above public interests when the upbuilding of a university is the task in hand.

There is another point, however, in connection with the teachers which must never be lost sight of, and that is the responsibility of the institution to a teacher who has been kept in his position for a considerable length of time. Unlike the work of business, the work of teaching undoubtedly tends to unfit a man for other occupations. The average teacher is out of contact with business affairs and, as a rule, confined within the narrow limits of his educational activities. It is true, particularly in applied science, that many teachers have opportunities for doing a considerable amount of outside work and for building up a consulting practice, so that they are not wholly dependent upon their teaching, and if they should discontinue the latter they would still be able to find profitable employment.

The number of such men, however, is comparatively few, and I think it is fair to say that the man who has remained in teaching for more than ten or fifteen years will generally find himself little adapted for anything else. In this lies the great importance of carefully scrutinizing the work of the young men in the teaching profession. An institution owes it to itself and to them to keep only the men who show conclusively their ability to succeed in the profession, and to get rid of the others before it is too late.

If the institution keeps men who are incompetent teachers, beyond the age when they are able to find other employment, it assumes a responsibility for providing for them in some way which it cannot shirk; yet it is very easy to keep a teacher in a subordinate position from mere force of habit or because no better man seems immediately available, although it might be easily foreseen that the time would come when for the good of the institution he ought to be replaced.

6. Another common defect in our teaching methods appears to be a lack of coordination. In many of our higher institutions, each teacher seems to be an unrestrained individual, following his own way, not only *teaching* his own subject in such manner as he pleases, but arranging his course and planning the ground to be covered without regard to anybody else. This criticism, if justified, is more apt to be applicable to our colleges than to technical schools in which a required curriculum is prescribed and in which there must be a sequence of studies; but even in these there appears to be some room for improvement.

When absolute independence of teaching is combined with the lecture system, it may perhaps fairly be said that in many cases the students simply listen to the individual views of their teachers instead of being submitted to a systematic and continuous course of discipline, which would seem to be the main object of education. It stands to reason that there should be close coordination between all the subjects taught in any institution, so far as they are related to each other. There should be no overlapping, except as this may, after definite consideration, be determined to be necessary or useful for purposes of repetition. One subject should naturally lead to another, and the sequence from the elementary to the difficult should be so continuous that no break should be perceptible. Whether the elective system or the prescribed curriculum is in use makes little difference, so long as each student is made to pass through a systematic course, involving continuous mental discipline.

Defects Due to Administration.

With reference to administration, the fundamental limitation to efficiency seems to me to lie in a fact which has already been referred to, namely, that the administrators—that is to say the trustees—have no financial interest at stake. This is the fundamental difference between the administration of a college and the administration of a business concern. Where men have no financial interest they cannot be expected to fully realize the responsibility, nor will they be apt to energetically take the necessary steps to insure efficiency.

For this reason, among others, I do not believe that education ever can be as efficient as business. I am not unmindful of the fact, of course, that there are many men who, if they accept positions on a board of college trustees, will take the same pains and feel the same responsibility as if they were trustees of a business corporation in which their own money as well as the funds of widows and orphans were invested; but this is somewhat contrary to human nature and must always be the exception. Money, or rather the love of it, may or may not be the root of all evil, but it certainly comes very near being the source of all efficiency.

This lack of concentration of responsibility is found not only in boards of trustees, but through the whole educational staff. The system of faculty government is not conducive to it. Instead of one man being at the head of one branch of the work and being responsible for it, he is in many instances not allowed to carry out his own ideas even in matters which concern his own branch alone. His views and perhaps those of the entire staff in his own branch, may be overborne by the votes in the faculty of men in entirely different branches who, perhaps, know little or nothing of the merits of the questions involved.

Of course, this may in some instances prove a benefit, for heads of departments are not exempt from error, and are not always wise. The point is, that responsibility is divided, and if those upon whom responsibility is placed are, as they should be, equal to the task, a division is always bad. Again, in the words of Dr. Draper, "University policies are not to be settled by majority vote. They are to be determined by expert opinion."

Nothing further need be said with reference to this phase of the question. Without concentration of responsibility, efficiency is undoubtedly diminished, and without direct financial interest, responsibility will not be heavily assumed. *When we combine a lack of direct financial interest in the product of education with the fact that the efficiency of the process is entirely intangible and incapable of any concrete expression, and the further fact that responsibility is divided, we have a combination which necessarily ensures a small percentage of efficiency—which constitutes its principal necessary limitation.*

I have endeavored to outline what the engineering graduate should be; what he unfortunately too often is; and have referred to some of the difficulties which are met in endeavoring to reach the ideal. Many of my remarks apply, of course, with even greater force to the college graduate also. The remedies, so far as remedies are possible, which have occurred to the writer have already been partially suggested. They may be summarized as follows:

1.—Every student in a university or technical school should be given systematic physical training and instruction in physiology.

2.—Education should not be considered to be merely mental education. Moral development should be kept constantly in mind and every teacher should not only endeavor to make himself a moral example, but, as far as consistent, to inculcate moral lessons.

3.—Educational work is not consistent with such concentration of responsibility as is possible in business, but it should be striven after so far as possible.

4.—Every effort should be made to cause the student to see the necessity for self-discipline and self-exertion, to realize the value of his opportunities, the importance of cultivating proper mental, moral, and physical habits, the fact that his success will depend upon himself alone, the necessity of studying how to work *effectively* and not simply *earnestly*. If he does not reasonably appreciate these things and take advantage of his opportunities, he should be promptly taken out of college and set to work earning his own living. Both parents and colleges are too lenient toward the indolent and the inefficient.

5.—Courses and examinations should be arranged, so far as possible, with the main object of training the student to observe and to think, and also, to a sufficient extent, to manipulate. It should be made impossible to pass in a course by rule-of-thumb work, mere memorizing, or cramming.

6.—The lecture system should be reduced to a minimum, so far as practicable.

7.—Students should be taught how to study, how to work effectively, and how to think logically. The systematic study of logic, in some form, might well be required in any engineering course.

8.—Teachers, at all events in the early portions of their careers, should be willing, and not only willing but glad, to submit to some scrutiny of their methods and results, should welcome kindly criticism, should discuss and study educational methods, and should be willing to modify their own methods. There should be cordial sympathy and harmony between the members of the faculty, and a spirit of earnest cooperation.

9.—Every student should be obliged to follow a carefully planned curriculum, involving continuous and systematic mental discipline. This does not mean that every student should follow the same curriculum, but that each man's course should be systematic in itself.

10.—Students in colleges and technical schools should not idle away their summer vacations, but should devote them entirely or largely to work of some kind. The other vacations during the year are sufficient for the physical needs of boys of 18 or over. Summer work should be either at shop work or at summer engineering camps, or in actual shops or other engineering establishments, where the student will see the opportunities for the practical applications of science, and will also learn that ability and wisdom are not confined to men who go to college, and that if he would surpass the untutored man

in the race of life it must be by getting an education.

But when all is said and done, the necessary limitations to efficiency in education will remain, these being largely due to the student himself and his lack of will, to the parent, who has given the boy no home discipline in the days of childhood, to the lack of financial incentive, and to the fact that efficiency cannot be measured.

Our colleges, no doubt, have serious defects—more serious on account of the extraordinary rapidity of their growth. But they are earnestly engaged in the attempt to solve a great problem. They may go wrong, they undoubtedly will go wrong at times, but they will discover their mistakes and correct them so far as practicable. They need in many respects to be reformed, and where they need it they will be reformed. They have, on the whole, done much good work, together with considerable poor work, but they will do better and better work as the years go by.

The Analytic Calculation of a Concrete Arch.

By MALVERD A. HOWE.*

In the following article it is proposed to take up in detail the necessary steps in designing an arch rib or ring of reinforced concrete, according to the elastic theory and the unit load method. Formulas will be given which render the calculations for unit loads under the exact method very simple. The methods in common use, while correct as far as they go, fall short in many particulars when the true maximum stresses are desired.

There is no method by which the dimensions of the arch ring for a given loading can be determined directly. The dimensions must first be assumed and calculations then made to determine if it fulfills all conditions of strength, etc. If the assumed ring is found too large or too small its dimensions must be changed, and this often leads to a new set of calculations. By the method to be explained the labor for the second and final calculations has been reduced to a minimum.

For purposes of calculation it is usually sufficient to consider a longitudinal slice of the bridge one foot in width. The longitudinal section shown in Fig. 1 is supposed to represent such a slice of the arch ring assumed to illustrate the methods of calculation. The ring is symmetrical about the crown in every particular, though the roadway over the arch may be on a grade, as the calculations apply to any distribution of loading.

The nomenclature employed in the following analysis is stated below and will be readily understood by referring to Fig. 2.

$\delta x = l/20$, the span being divided into twenty equal parts in all cases.

W_1, W_2, etc. = concentrated loads applied at points No. 1, No. 2, etc.

m_x = the statical moment at any point of the arch, i. e., the moment of the external forces when the arch is considered as merely resting on its supports.

a = the abscissa of the load W, from the left support. As under the unit-load method only one load is considered at a time, the abscissa a is a constant in each formula, having the value a_1, a_2, etc., corresponding to the load considered, W_1, W_2, etc.

$k = a \div \frac{1}{2}\delta x$, giving a measure of a independent of the length of span.

x_1, x_2, etc. = the abscissas of points No. 1, No. 2, etc., referred to the left support. Where x occurs in a summation it is a variable.

$z = x \div \frac{1}{2}\delta x$, giving a measure of x independent of the length of span.

y_1, y_2, etc. = the ordinates of points No. 1, No. 2, etc.

δs_1 = length of arch axis having horizontal projection equal to δx, point No. 1 bisecting δx.

δs_2 = length of arch axis having horizontal projection equal to δx, point No. 2 bisecting δx

*Professor of Civil Engineering, Rose Polytechnic Institute, Terre Haute, Ind.

$$\triangle_1, \triangle_2, \text{ etc.} = \frac{\delta s_1}{I_1}, \frac{\delta s_2}{I_2}, \text{ etc.},$$

where I is the moment of inertia of the arch cross-section.

Σ = sum from G to G'.

$\sum_{z=0}^{z=k}$ = sum from 0 to k inclusive, or from G to the point where the particular load being considered is applied. For example, for W_7 the sum is from 0 to $z = 13$.

$\sum_{z>k}^{z=19}$ = sum between the point of application of the particular load being considered and the crown of the arch. For example, for W_7 the sum is to be taken for $z = 15$, 17 and 19.

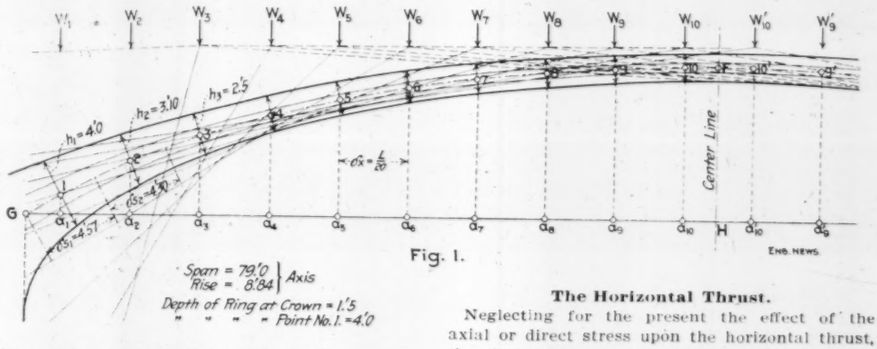

Fig. 1.

V_1 = vertical reaction at left support.

V_2 = vertical reaction at right support.

H = horizontal thrust produced by vertical loading.

H_a = horizontal thrust produced by axial thrust.

H_t = horizontal thrust produced by temperature changes.

M_1 = moment at left support for whatever loading is being considered.

M_2 = moment at right support for whatever loading is being considered.

The formulas employed are those given in the writer's "Symmetrical Masonry Arches" and "A Treatise on Arches," modified so that the computations become almost mechanical. The work

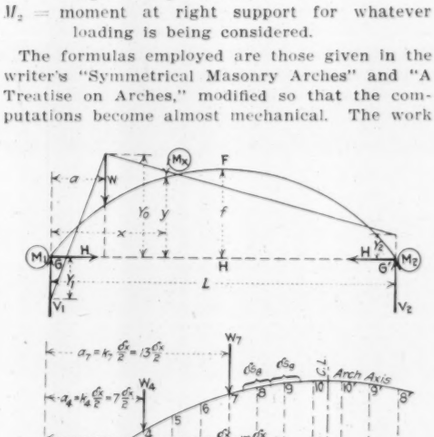

Fig. 2.

is rapidly performed with the aid of Crelle's "Rechentafeln" or a multiplying machine and an adding machine.

Having decided upon the shape and dimensions of the ring, carefully draw an elevation of one-half of the ring to any convenient scale. Construct the medial line GF Fig. 1, and draw GH horizontal. Divide GH into ten equal parts, and at the centers of these segments erect the verticals, $a_1 1$, $a_2 2$, $a_3 3$, etc., intersecting the medial line of the arch ring at 1, 2, 3, etc. Designate Ga_1 by x_1, Ga_2 by x_2, etc.; $a_1 1$ by y_1, $a_2 2$ by y_2, etc.; that is to say, the coordinates of point 1 are x_1, y_1, those of 2 are x_2, y_2, etc. GH is one-half the span to be used in the calculations and $HF = f$ is the rise.

At each of the points 1, 2, 3, etc., carefully scale the *radial* depths of the ring, designating them as h_1, h_2, h_3, etc., respectively. The corresponding axial lengths of the arch-ring segments are denoted by δs_1, δs_2, δs_3, etc., as clearly shown in Fig. 1.

On the right of the crown a similar figure is assumed to exist, with all letters and figures primed. For example, a'_1 is as far to the right of H as a_1 is to the left; $a_1 1 = a'_1 1'$, $a_2 2 = a'_2 2'$; $h_1 = h'_1$, $h_2 = h'_2$.

The moments of inertia I_1, I_2, etc., at points 1, 2, 3, etc., can now be computed. The values of I for the specimen arch are given in Col. 12, Table I.

The Horizontal Thrust.

Neglecting for the present the effect of the axial or direct stress upon the horizontal thrust, the thrust due to vertical loads is:

$$H = \frac{\Sigma m_x \triangle \left(y - \frac{\Sigma y \triangle}{\Sigma \triangle} \right)}{\Sigma y \triangle \left(y - \frac{\Sigma y \triangle}{\Sigma \triangle} \right)} W = \frac{\Sigma m_x \triangle (y - K)}{\Sigma y \triangle (y - K)} W$$

This formula is deduced directly from the fundamental equations $\Sigma M_x \triangle = 0$, $\Sigma M_x x \triangle = 0$ and $\Sigma M_x y \triangle = 0$.

For a *single load* W distant $a = k \frac{\delta x}{2}$ from the left support this may be reduced to

$$H = \frac{\sum_{z=0}^{z=k} z B + k \sum_{z>k}^{z=19} B}{\Sigma D} W \left(\frac{\delta x}{2} \right) = \frac{C}{\Sigma D} W \frac{\delta x}{2}$$

where

$$D = y \triangle (y - K) = y B$$

$$C = \sum_{z=0}^{z=k} z B + k \sum_{z>k}^{z=19} B = \Sigma m_x \triangle (y - K)$$

$$B = \triangle (y - K)$$

The values B and D are entirely independent of the position and magnitude of the loading, and consequently may be considered as constants for this particular arch ring. For convenience the application of the loads has been assumed at the center points 1, 2, 3, etc., of the arch segments; this simplifies the calculation of C.

Table II gives the calculation of B and D in detail. When the numerical work is exact Col. 6 adds up zero.

Having determined the values of B and ΣD, the value of H for a load W_1 at point 1, W_2 at point 2, etc., can be quickly found as shown in Table III. The coefficients in Col. 9 are constants for this arch ring. They are actually the horizontal thrusts produced by *unit loads*. The value of H for any load at any point can be found by simple multiplication. In case the load is not applied at one of the points 1, 2, 3, etc., it is only necessary to plot the coefficients in Col. 9 and read off the coefficient for the given load, from a curve drawn through the plotted points.

Owing to symmetry the horizontal thrust produced by a unit load at point 2' is equal to that produced by a unit load at point 2; and similarly for any pair of symmetrical points.

With Col. 9, Table III, once determined, the value of H for any loading is quickly found, and any desired change in loading requires but a few minutes to correct the values of H.

The numerical work can be checked by computing the value of H for a unit load at each of the twenty points 1 to 1′ as indicated in Table IV. The quantities m' in Col. 2 are the same for any arch where the span is divided into twenty equal parts, as was done in Fig. 1.

Bending Moments at the Supports.

The moments M_1 and M_2 for any load W at any point, 1 or 2 or 3 or 4, etc., can be found from the formula

$$\left.\begin{matrix} M_1 \\ M_2 \end{matrix}\right\} = H\,K - \left\{ \left[\sum_{z=0}^{z=k} z\,\triangle + k \sum_{z>k}^{z=19} \triangle \right] \frac{\delta x}{2 \Sigma \triangle} \right.$$

$$\times \left[(20-k) \sum_{z=0}^{z=k} (z-20)\,20\,\triangle - k \sum_{z>k}^{z=19} (z-20)^2 \triangle \right]$$

$$\left. \frac{\delta x}{800 \Sigma \triangle - 2 \Sigma z^2 \triangle} \right\} W$$

or

$$\left.\begin{matrix} M_1 \\ M_2 \end{matrix}\right\} = G - \left\{ Z \pm O\,Q \right\} W$$

Although this formula looks long and complex it is in fact very simple and easy in its application.

For each load the value of H is given in Col. 9, Table III. From Col. 8, Table II, $K = 7.6401$. From Col. 2, Table II $\Sigma\triangle = 117.28$. The values of $\triangle$ are given in Col. 13 of Table I.

Taking the terms Z, O, and Q in order: The numerical work for Z is given in Table V. This is so simple that further explanation seems unnecessary.

Table VI. contains the numerical work necessary to obtain O and Q. Cols. 2, 3, 4, 5, 13 and 14 are constant for any arch where the span is divided into twenty equal parts as shown in Fig. 1.

Combining the terms Z, O, Q and G as shown in Table VII, the values of M_1 and M_2 for loads at the points 1-10, inclusive, are found. Owing to symmetry, it is evident that the value of M_2 for a unit load at point 1 is the value of M_1 for a unit load at point 1′, and similarly for any pair of symmetrical points.

To check the numerical work compute the value of M_1 for a unit load at each point 1-1′, inclusive, as shown in Table VIII. The value of M_1 in Col. 4, Table VIII, should be the same as the value of M_1 in Col. 9, Table VII. Again, the sum of Col. 3, Table VIII should equal the sum of Col. 9, Table V.

As in the case of H, the coefficients in Cols. 7 and 8, Table VII are the values of M_1 and M_2 for *unit loads*. Having these coefficients the values of M_1 and M_2 for any combination of loading are quickly determined.

Vertical Reactions.

It is necessary to consider only the left reaction, V_1, which may be found from the formula

$$V_1 = \frac{M_2 - M_1}{L} + W \frac{40 - k}{40}$$

The values of V_1 are given in Table IX.

Dead Load.

Having the values of H, M_1 and V_1, the equilibrium polygon for any loading can be constructed in the usual manner, beginning at the left support distant vertically from G, Fig. 1, by the amount $Y_1 = \frac{M_1}{H}$. To illustrate the use of the coefficients the value of Y_1 will be determined for the dead load which was computed for the assumed ring. And to further illustrate the use of the coefficients the dead load will be taken unsymmetrical, as would be the case if the roadway was on a uniform grade.

Col. 2 of Table (A) contains the value of W for each point. Col. 3 is the product of the values of W in Col. 2 multiplied by the corresponding coefficient for H given in Table IX. The values of M_1, M_2 and V_1 are found in a similar manner, using the coefficients for M_1, M_2 and V_1 as given in Table IX. If the loading had been symmetrical about one-half of the labor would have been saved.

The values used may be written in round numbers $H = 61{,}100$, $M_1 = +4{,}600$, $M_2 = +37{,}800$, $V_1 = 36{,}000$ and $V_2 = 32{,}500$.

The equilibrium polygon at the left support is $\frac{+4{,}600}{61{,}100} = 0.07$ ft. above G, Fig. 2, and at the right support $\frac{+37{,}800}{61{,}100} = 0.6$ ft. above G'.

Live Load.

In considering the live load it is necessary to know the effect of each load at any particular section of the ring. The easiest way to determine this is to construct the equilibrium polygon for a unit load at each point respectively. Three points, determined by the ordinates Y_0, Y_1 and Y_2 (Fig. 2), completely locate the polygon for any single load.

TABLE A.

1 For point.	2 W lbs.	3 H lbs.	4 M_1 lb.-ft.	5 M_2 lb.-ft.	6 V_1 lbs.
1	7,100	0	−14,023	+ 0	7,100
2	5,700	410	−29,674	+ 2,462	5,677
3	4,600	1,127	−34,746	+ 6,486	4,536
4	3,900	2,102	−31,551	+11,879	3,767
5	3,300	3,095	−24,278	+16,740	3,076
6	2,800	3,940	−14,790	+20,187	2,472
7	2,500	4,722	− 5,601	+22,643	2,045
8	2,300	5,343	+ 2,894	+23,580	1,700
9	2,100	5,557	+ 9,820	+21,950	1,361
10	2,000	5,636	+15,103	+19,084	1,100
10′	1,900	5,354	+18,130	+14,348	855
9′	2,000	5,292	+20,904	+ 9,352	704
8′	2,100	4,879	+21,530	+ 2,642	548
7′	2,300	4,345	+20,830	− 5,152	419
6′	2,500	3,518	+18,025	−13,204	293
5′	2,800	2,627	+14,204	−20,600	190
4′	3,300	1,779	+10,052	−26,700	112
3′	4,000	980	+ 5,640	−29,390	56
2′	5,000	360	+ 2,160	−26,030	20
1′	6,300	0	0	−12,443	0
	68,500	61,066	+ 4,629	+37,834	36,034

$V_2 = 68{,}500 - 36{,}034 = 32{,}466.$

TABLE I.—ARCH-RIB COMPUTATIONS—GENERAL DATA.

1 For Point Number	2 $\frac{40}{L}\frac{x}{z}$	3 y	4 δs	5 h	6 h^3	7 $\frac{h^3}{12} \div I_c$	8 $\frac{h}{2}$	9 $0.31 \equiv \frac{h^3}{I_c} \div 24$	10 $(h')^2$	11 $0.24\,(h')^2 \div I_c$	12 $I + I_0 = I'$	13 $\frac{\delta s}{I} \div \triangle$	14 Remarks
1	1	1.26	4.57	4.00	64.000	5.333	2.00	1.69	2.856	0.683	6.016	0.76	Span = L
2	3	3.18	4.30	3.10	29.791	2.483	1.55	1.24	1.538	0.369	2.852	1.51	= 79.0 ft.
3	5	4.70	4.18	2.50	15.625	1.302	1.25	0.94	0.884	0.212	1.514	2.76	Rise = f,
4	7	5.90	4.11	2.18	10.360	0.863	1.09	0.78	0.608	0.146	1.009	4.07	= 8.84 ft.
5	9	6.82	4.05	1.94	7.301	0.608	0.97	0.66	0.436	0.105	0.713	5.68	Above dimensions
6	11	7.52	4.01	1.80	5.832	0.484	0.90	0.59	0.348	0.084	0.568	7.06	refer to the
7	13	8.04	3.99	1.72	5.088	0.424	0.86	0.55	0.303	0.073	0.497	8.03	linear arch.
8	15	8.44	3.98	1.64	4.411	0.368	0.82	0.51	0.260	0.062	0.430	9.25	Depth at the
9	17	8.70	3.97	1.62	4.252	0.354	0.81	0.50	0.250	0.060	0.414	9.59	crown = 1.5 ft.
10	19	8.80	3.96	1.60	4.096	0.341	0.80	0.49	0.240	0.058	0.399	9.92	
												58.64 / 2	Steel = 2.305 sq. ins.
												$\Sigma\triangle = 117.28$	$\frac{E_s}{E_c} = 15$

Cols. 3-13, inclusive, are true for symmetrical points on the right of the crown since the arch is symmetrical.

TABLE II.—ARCH-RIB COMPUTATIONS FOR CONSTANTS B AND D.

1 For Point Number	2 $\triangle$	3 y	4 $y\triangle$	5 $y - K \div (y - 7.6401)$	6 $\triangle (y - 7.6401) = B$	7 $yB = D$	8 Remarks
1	0.76	1.26	0.9576	−6.3801	− 4.8489	− 6.110	Cols. 2 and 3 are repeated from Table I.
2	1.51	3.18	4.8018	−4.4601	− 6.7348	− 21.417	
3	2.76	4.70	12.9720	−2.9401	− 8.1147	− 38.139	
4	4.07	5.90	24.0130	−1.7401	− 7.0822	− 41.785	$K = \frac{896.0356}{117.28} = 7.6401$
5	5.68	6.82	38.7376	−0.8201	− 4.6582	− 31.769	
6	7.06	7.52	53.0912	−0.1201	− 0.8479	− 6.376	
7	8.03	8.04	64.5612	+0.3999	+ 3.2112	+ 25.818	
8	9.25	8.44	78.1544	+0.7999	+ 7.3991	+ 62.448	$\Sigma B = O$ when numerical work is exact.
9	9.59	8.70	83.4330	+1.0599	+10.1644	+ 88.430	
10	9.92	8.80	87.2960	+1.1599	+11.5062	+101.255	
	58.64 / 2		448.0178 / 2		−32.2867 / +32.2809	−145.596 / +277.951	
	117.28 $\Sigma\triangle$		896.0356 $\Sigma y\triangle$		0.0058 / 2 / 0.0116 ΣB	+132.355 / 2 / +264.710 ΣD	ΣD = denominator of expression for H, and is constant for this arch ring.

TABLE III.—ARCH-RIB COMPUTATIONS FOR HORIZONTAL THRUST H.

1 For Point Number	2 z	3 zB	4 $k = \frac{40}{L} a$	5 $\sum_{z=0}^{z=k} zB$	6 $\sum_{z>k}^{z=19} B$	7 $k \sum_{z>k}^{z=19} B$	8 Cols. 5 + 7 C	9 $\frac{C}{\Sigma D} \frac{\delta x}{2} W \div H$	10 For a Load W at Point Number
1	1	− 4.849	1	− 4.849	4.842	4.842	0	0 W_1	1
2	3	− 20.204	3	− 25.053	11.577	34.731	9.678	0.072 W_2	2
3	5	− 40.574	5	− 65.627	19.692	98.460	32.833	0.245 W_3	3
4	7	− 49.575	7	−115.202	26.774	187.418	72.216	0.539 W_4	4
5	9	− 41.924	9	−157.126	31.432	282.888	125.762	0.938 W_5	5
6	11	− 9.327	11	−166.453	32.280	355.080	188.627	1.407 W_6	6
7	13	+ 41.746	13	−124.707	29.069	377.897	253.190	1.889 W_7	7
8	15	+110.987	15	− 13.720	21.670	325.050	311.330	2.323 W_8	8
9	17	+172.795	17	+159.075	11.506	195.602	354.677	2.646 W_9	9
10	19	+218.618	19	+377.693	0	0	377.693	2.818 W_{10}	10
							1,726.006	12.877 / 2	
								25.754	

Col. 9 is true for symmetrical points on the right of the crown. If $W_1 = W_2 = W_3$ &c $= W$ for each point $H = 25.754\,W$.

From Table II. $\Sigma D = 264.710$.

ΣH when all loads are unity.

TABLE IV.—ARCH-RIB COMPUTATIONS. CHECK COMPUTATIONS FOR H UNDER FULL UNIFORM LOAD.

1 For Point number.	2 m'	3 B	4 $m'B$	5 Remarks
1	10	− 4.8489	− 48.490	For a load unity at each point,
2	28	− 6.7348	− 188.580	
3	44	− 8.1147	− 357.060	$H = \frac{2 \sum_0^{L/2} (m')\,B}{\Sigma C} \frac{\delta x}{2} = \frac{1725.960}{264.710}$ (3.95)
4	58	− 7.0822	− 410.756	
5	70	− 4.6582	− 326.060	
6	80	− 0.8479	− 67.840	
7	88	+ 3.2112	+ 282.568	
8	94	+ 7.3991	+ 695.506	
9	98	+10.1644	+ 996.072	
10	100	+11.5062	+1,150.600	
			−1,398.786	
			+3,124.746	
			+1,725.960	

$\therefore H = \frac{1725.960}{67.015} = 25.754$ the same as found in Col. 9 of Table III.

Compare sum of Col. 8, Table III., with sum of Col. 4, Table IV.

$$Y_0 = Y_1 + \frac{V_1}{H} a,$$

$$Y_1 = \frac{M_1}{H},$$

$$\text{and } Y_2 = \frac{M_2}{H}.$$

The values of these ordinates are given in Table IX. and the polygons are drawn in Fig. 1.

To illustrate the use of these polygons take the section at point 6. The ring has been divided into three equal divisions at each point, for (neglecting the effect of the steel) it is well known that any normal force applied at the third point of the rectangular section produces no stress at one extreme fiber and a stress of maximum intensity at the other, or twice the average intensity. In Fig. 1 at section 6 it appears that the equilibrium polygon for W_9 passes through the lower third point of the section, hence the intensity of the stress at the upper limit of section 6 is zero for this load. Inspection shows that the equilibrium polygon for all loads upon the left of W_9 cut this section above the lower third point, and hence these loads W_1 to W_9 inclusive add to the compression at the upper limit of the section. Inspection also shows that no polygon for loads upon the right of W_9 cuts the section above the lower third point; therefore, loads upon the left of W_9 produce maximum compression at the upper limit of the section and loads upon the right of W_9 produce maximum tension at the same point. For the lower limit of the section the load producing no stress lies between W_7 and W_8. In like manner any other section may be examined.

The bending moment at any section is

$$M_x = M_1 + V_1 x - H y - \sum_{a=0}^{a=x} W(x-a)$$

This requires the values of M_1, V_1 and H for the loading considered. Let the load be assumed uniform, then $W_1 = W_2 = W_3 = W$. Take the loads 1-9 inclusive for section 6: From Table IX., opposite 9

$$\Sigma H = 10.059 \therefore H = 10.059\ W.$$
$$\Sigma M_1 = -31.553 \therefore M_1 = -31.553\ W.$$
$$\Sigma V_1 = 7.967 \therefore V_1 = 7.967\ W.$$

and

$$M_x = \left[-31.553 + 7.967\,x - 10.059\,y - \sum_{a=0}^{a=x} W(x-a)\right] W$$

If the equilibrium polygon is drawn it starts at

$$Y_1 = \frac{-31.553}{10.059} = -3.2, \text{ i. e., } 3.2 \text{ ft. } \textit{below } G.$$

The better way is to construct the equilibrium polygon for the dead-load and live-load combined. Let $W = 1{,}000$ for live-load.

For D. L. $H = 61{,}100$ $M_1 = +4{,}600$ $V_1 = 36{,}000$
For L. L. $H = 10{,}059$ $M_1 = -31{,}553$ $V_1 = 7{,}967$

Total 71,159 −26,953 43,967

$$Y_1 = \frac{-26{,}953}{71{,}159} = -0.37,$$ or the polygon starts 0.37 ft. below G, Fig. 2.

In like manner the polygons for any combination of loading can be quickly constructed.

Temperature.

For changes in temperature

$$H_t = \frac{e\,t^\circ E}{\Sigma D} L$$

$$M_{1t} = H_t K$$

$$M_{xt} = M_{1t} - H_t y = -H_t (y - K)$$

where

H_t = horizontal thrust due to change in temperature.
M_{1t} = moment at left support due to change in temperature.
e = coefficient of expansion for material composing the arch rib.
t° = number of degrees change in temperature.
E = Young's modulus for material composing arch ring.

From Col. 7, Table II. $\Sigma D = 264.710$. From Col. 5, Table II., can be found the values of yK, and $K = 7.6401$.

For a rise in temperature H_t is of the same kind as the H for vertical loads and considered as positive in the above formulas.

The Effect of the Direct Stress.

The above formulas have considered the effect of bending only. For a rigid analysis and for very flat arches the effect of the axial or direct stress should not be neglected. For all practical purposes the horizontal thrust due to the axial stress may be found from the formula

$$H_a = H \left\{ 1 - \frac{\Sigma D}{\Sigma D + \Sigma \frac{(\delta x)^2}{F\,\delta s}} \right\}$$

Where ΣD is given in Table II.; $\delta x = L \div 20$; F = area of section of arch rib at points 1, 2, 3, etc., respectively; and δs is given in Table I.

For changes in temperature H becomes H_t in above formula.

TABLE V.—ARCH-RIB COMPUTATIONS FOR TERM Z IN END MOMENT FORMULA.

1 For Point Number	2 z	3 k	4 $\triangle$	5 $z\triangle$	6 $\sum_{z=0}^{z=z} z\triangle$	7 $\sum_{z>k}^{z=19} \triangle$	8 $k\sum_{z>k}^{z=19} \triangle$	9 Cols. 6+8	10 Z	11 Remarks
1	1	1	0.76	0.76	0.76	57.88	57.88	58.64	0.9875	Cols 2, 3 and 4 are repeated from previous tables.
2	3	3	1.51	4.53	5.29	56.37	169.11	174.40	2.937	
3	5	5	2.76	13.80	19.09	53.61	268.05	287.14	4.835	
4	7	7	4.07	28.49	47.58	49.54	346.78	394.36	6.640	
5	9	9	5.68	51.12	98.70	43.86	394.74	493.44	8.308	
6	11	11	7.06	77.66	176.36	36.80	404.80	581.16	9.785	
7	13	13	8.03	104.39	280.75	28.77	374.01	654.76	11.024	4878.68 (0.01684) = 82.114 check.
8	15	15	9.25	138.90	419.65	19.51	292.65	712.30	11.993	
9	17	17	9.59	163.03	582.68	9.92	168.64	751.32	12.651	
10	19	19	9.92	188.48	771.16	0	0	771.16	12.983	
			58.64		2,402.02		2,476.66	4,878.68	82.144	
			2							
			117.28 $\Sigma\triangle$		Sum of Col. 6 + sum of Col. 8 = sum of Col. 9. 2,402.02 + 2,476.66 = 4,878.68 check					

$$Z = \frac{\text{Cols. } (6+8)}{2\,\Sigma\triangle}\,\delta x = \frac{\text{Col. } (9)}{234.56} = \text{Col. } (9)\ (0.01684).$$

TABLE VI.—ARCH-RIB COMPUTATIONS FOR TERMS O & Q IN END MOMENT FORMULA.

1 For Point No.	2 $20-k$	3 $z-20$	4 $z(z-20)$	5 $(z-20)^2$	6 $z(z-20)\triangle$	7 $\sum_{z>k}^{z=19} z(z-20)\triangle$	8 $(20-k)\sum_{z>k}^{z=19} z(z-20)\triangle$	9 $(z-20)^2\triangle$	10 $\sum_{z>k}^{z=19} (z-20)^2\triangle$	11 $\sum_{z>k}^{z=19} (z-20)^2\triangle$	12 Cols. (8−11) O	13 z	14 $z^2\triangle$	15 $z^2\triangle$	16 $\frac{O}{40.51}$ OQ
1	19	−19	19	361	− 14.44	− 14.44	− 274.36	274.36	3,725.56	3,725.56	− 3,999.92	1	1,522	1,156.72	0.987
2	17	−17	−51	289	− 77.01	− 91.45	− 1,554.65	436.69	3,289.17	9,867.51	− 11,422.16	3	1,378	2,080.78	2.819
3	15	−15	−75	225	−207.00	− 298.45	− 4,476.75	621.00	2,688.17	13,340.85	− 17,817.66	5	1,250	3,450.00	4.373
4	13	−13	−91	169	−370.37	− 668.82	− 8,694.66	687.83	1,980.34	13,862.38	− 22,557.04	7	1,138	4,631.66	5.568
5	11	−11	−99	121	−562.32	−1,231.14	−13,542.54	687.28	1,293.06	11,637.54	− 25,180.08	9	1,042	5,918.56	6.215
6	9	− 9	−99	81	−698.94	−1,930.08	−17,370.72	571.86	721.20	7,933.20	− 25,303.92	11	962	6,791.72	6.246
7	7	− 7	−91	49	−730.73	−2,660.81	−18,625.67	393.47	327.73	4,260.49	− 22,886.16	13	898	7,210.94	5.649
8	5	− 5	−75	25	−694.50	−3,355.31	−16,776.55	231.50	96.23	1,443.45	− 18,220.00	15	850	7,871.00	4.497
9	3	− 3	−51	9	−489.09	−3,844.40	−11,533.20	86.31	9.92	168.64	− 11,701.84	17	818	7,844.62	2.888
10	1	− 1	−19	1	−188.48	−4,032.88	− 4,032.88	9.92	0	0	− 4,032.88	19	802	7,955.84	0.995
							−96,881.96			66,239.62	−163,121.60			54,911.84	
					From Col. 11		+66,239.62				See Col. 8			$\Sigma z^2\triangle$	
					See Col. 12		−163,121.58 check				δx		3.95		−1

$$Q = \frac{}{800\,\Sigma\triangle - 2\,\Sigma z^2\triangle} = \frac{}{800\ (117.28) - 2\ (54{,}911.84)} = \frac{}{4{,}051}$$

*Symmetrical values combined.

TABLE VII.—ARCH-RIB COMPUTATIONS. VALUES OF END MOMENTS.

1 For Load at Pt. No.	2 Z Table V. Col. 10	3 OQ Table VI. Col. 16	4 $Z+OQ$	5 $Z-OQ$	6 $\frac{HK}{G}$ 7.6401 H	7 M_1	8 M_2	9 Remarks
1	0.988	0.987	1.975	*.001	$0W_1$	$-1.975W_1$	$0W_1$	If $W_1 = W_2 = W_3$ = unity
2	2.973	2.819	5.756	0.118	$.550W_2$	$-5.206W_2$	$+ .432W_2$	
3	4.835	4.373	9.208	0.462	$1.872W_3$	$-7.336W_3$	$+ 1.410W_3$	
4	6.640	5.568	12.208	1.072	$4.118W_4$	$-8.090W_4$	$+ 3.046W_4$	$\Sigma M_1 = \begin{cases} +69.960 \\ -37.487 \end{cases}$
5	8.308	6.215	14.523	2.093	$7.166W_5$	$-7.357W_5$	$+ 5.073W_5$	
6	9.785	6.246	16.031	3.539	$10.749W_6$	$-5.282W_6$	$+ 7.210W_6$	or + 32.473
7	11.024	5.649	16.673	5.375	$14.432W_7$	$-2.241W_7$	$+ 9.057W_7$	
8	11.993	4.497	16.490	7.496	$17.748W_8$	$+ 1.258W_8$	$+10.252W_8$	
9	12.651	2.888	15.539	9.763	$20.215W_9$	$+ 4.676W_9$	$+10.452W_9$	
10	12.983	0.995	13.978	11.988	$21.530W_{10}$	$+ 7.552W_{10}$	$+ 9.542W_{10}$	
					98.380	−32.473 +13.486	+56.474	

$M_1 = M_2$ for loads on right of crown.
$M_2 = M_3$ for loads on right of crown.
*Should be zero.

$$\left.\begin{matrix} M_1 \\ M_2 \end{matrix}\right\} = HK - \left\{ Z \pm OQ \right\} W$$

It appears that H_a is in constant ratio to H, and in effect reduces H as found from the common formula. Then H_a may be considered in effect as a *drop* in temperature and therefore

$$M_{xa} = H_a (y - K)$$

The simplest way of considering the effect of H_a is to compute the intensities of the fiber stress at the various cross-sections considered, for H_a = unity and then by simple proportion find the stresses for any H.

Changes in Dimensions.

After a part or all of the sections have been examined for various loading, it may appear that the arch ring is too small. Assume that it must be made 6 ins. deeper at the crown. This will not seriously affect the dead-load but appar-

TABLE VIII.—ARCH-RIB COMPUTATIONS CHECK COMPUTATION FOR M_1 UNDER FULL UNIFORM LOAD.

1 For Point No.	2 m'	3 $m'\Delta$	4 Remarks.
1	10	7.60	$M_1 = H\ K - \frac{\Sigma m\Delta}{\Sigma\Delta} = H\ \ K - \frac{\Sigma m'\Delta}{\Sigma\Delta} \quad \frac{\delta x}{2}$
2	28	42.28	
3	44	121.44	
4	58	236.06	
5	70	397.60	
6	80	564.80	$M_1 = (25.754)\ (7.6401) - \frac{9,757.36}{117.28} - (1.975) = +32.476$
7	88	706.64	
8	94	870.44	
9	98	939.82	In Table VII, Col. 9, $M_1 = +32.473$, which differs but 0.003 from the value just found.
10	100	992.00	
		4,878.68	
		2	
		9,757.36	

TABLE IX.—ARCH-RIB COMPUTATIONS. COEFFICIENTS FOR UNIT LOADS.

1 For Point No.	2 H	3 ΣH	4 M_1	5 ΣM_1	6 V_1	7 ΣV_1	8 Y_0	9 Y_1	10 Y_2
1	0	0	— 1.975	— 1.975	1.000	1.000	....	....	....
2	0.072	0.072	— 5.206	— 7.181	.996	1.996	9.60	—72.37	6.00
3	0.245	.317	— 7.336	—14.517	.986	2.982	9.80	—29.94	5.75
4	0.539	.856	— 8.090	—22.607	.966	3.948	....	—15.01	5.65
5	0.938	1.794	— 7.357	—29.964	.931	4.879	9.80	— 7.84	5.41
6	1.407	3.201	— 5.282	—35.246	.883	5.762	9.88	— 3.75	5.13
7	1.889	5.090	— 2.241	—37.487	.818	6.580	9.93	— 1.19	4.79
8	2.323	7.413	1.258	—36.229	.739	7.319	9.96	0.54	4.41
9	2.646	10.059	4.676	—31.553	.648	7.967	9.99	1.77	3.95
10	2.818	12.877	7.552	—24.001	.550	8.517	10.00	2.68	3.38
10′	2.818	15.695	9.542	—14.459	.450	8.967	10.00	3.38	2.68
9′	2.646	18.341	10.452	— 4.007	.352	9.319	9.99	3.95	1.77
8′	2.323	20.664	10.252	6.245	.261	9.580	9.96	4.41	0.54
7′	1.889	22.553	9.057	15.302	.182	9.762	9.93	4.79	— 1.19
6′	1.407	23.960	7.210	22.512	.117	9.879	9.88	5.13	— 3.75
5′	0.938	24.898	5.073	27.585	.069	9.948	9.80	5.41	— 7.84
4′	0.539	25.437	3.046	30.631	.034	9.982	....	5.65	—15.01
3′	0.245	25.682	1.410	32.041	.014	9.995	9.80	5.75	—29.94
2′	0.072	25.754	0.432	32.473	.004	10.000	9.60	6.00	—72.37
1′	0	25.754	0	32.473	0	10.000			

ently makes useless the computations for H, M_1, V_1, etc. An inspection of the expression for H shows that the values of $\Delta = \delta s \div I$ may be changed by any ratio without affecting the value of H. This fact makes it possible to change the dimensions of the arch ring without changing the coefficients for H, by simply changing the moments of inertia at each point in the same ratio. In the case assumed here find the value of I for the section increased in depth by 6 ins. and its ratio to the value of I for this section given in Table I., and then change the values of I at the other section by the same ratio. The new depths can be computed from the new values of I. Then *all the values of* H, M_1, M_2, *etc., for the dead and live loads found by the first calculation remain the same,* and it is only necessary to recompute the intensities of the fiber stresses.

The value of H for changes in temperature will be *increased* or *decreased* in exactly the same ratio as the moments of inertia.

The value of H_a will have to be recomputed, but this requires only a very little labor, as $\Sigma\ D$ will simply be multiplied by the ratio of the moments of inertia and F will be the new areas.

Even the span, rise or both can be changed without making a new set of computations for the coefficients of H, M_1, M_2, etc., but the explanation of the method would prolong this article to too great a length.

Civil Service Examinations for Assistant Water-Supply Engineer, Hydraulic Engineer and Transitman.

By "SUBSCRIBER."

The following questions are not in the exact language as originally given, but especial endeavor was made to fix the questions in mind and they were written out within a few hours after the close of the examination. It is believed, therefore, that the wording is such as to convey the ideas intended in the questions propounded by the examiners. The numerical values given in the various questions were obtained from figuring papers.

Assistant Engineer.

On Aug. 3, 1909, the Municipal Civil Service Commission of the City of New York, held an examination for Assistant Engineer, Board of Water Supply. This board is charged with the construction of the new Catskill Aqueduct for supplying New York City with water from the Catskill Mountains. The position carries with it a salary of $1,350, and upwards, per annum. The minimum age limit was 21 years.

The examination proper consisted of a technical paper having a weight of 50; a mathematical paper with a weight of 15; and a report with a weight of 15. In addition to the above, experience carried a weight of 20 and was rated from a paper sent to the candidate with his card of admission to the examination. The experience paper had to be filled out in the candidate's own handwriting, subscribed and sworn to and was handed in at the beginning of the examination. The passing requirements were a mark of 75% on the technical paper and 70% on all subjects. The technical paper was in two parts and the time allowed was from a little after 10 a. m. until 1 p. m. From 1 to 4.30 p. m. was allowed for the mathematical paper and the report.

That it was not an easy examination is shown by the fact that of about 430 candidates only 105, or less than one-third, were passed. Although many would undoubtedly consider the examination severe, it would appear to be an eminently fair one, for there were no catch questions, and an exceedingly practical one, since each question was on a subject that a man in the position would be likely to meet with at any time.

TECHNICAL.—1. Suppose you were furnished with the form, dimensions, material, and slope of a proposed aqueduct, how would you determine the quantity of water that it would carry in a given time?

2. Suppose the aqueduct had been in use for some time; how would you then determine the quantity of water flowing at any given time?

3. Sketch roughly to scale the cross-section of an earthen dam 30 ft. high, with a core wall, showing the slopes, disposition of the different sizes of material and finish of the surfaces.

4. Suppose a trench for a puddle wall has been excavated to the required depth; what would be the next step to take (a) Where the bottom is earth? (b) Where the bottom is rock?

5. (a) In placing a layer of earth on an earthen surface, as in an embankment for a reservoir, so as to prevent water passing between the two layers, state what should be the condition of the surface on which the new layer is placed. (b) Give the thickness of the new layer both when first put down and when completed.

6. (a) State what will prevent the lower bed of a stone from being in perfect contact with the mortar on which it is placed. (b) Explain in detail how these troubles may be overcome in the building of a dam.

7. (a) How should the stone in either a stone or a concrete and stone dam be arranged, in order to give the greatest strength and the least liability of water passing through the masonry? Give your reasons. (b) Describe fully and clearly the class of masonry that accomplishes this result in the best manner.

8. (a) In gravel or sand of approximately a uniform size of grain, state about what proportion of the entire bulk is composed of voids. (b) How could these voids be reduced to a minimum in a practical manner?

9 (a) State in general the considerations which determine the amount of steel to be used for reinforcing concrete. (b) In what position should the steel be placed? Answer fully.

10. State all the losses of head to which water in passing through pipes is subjected; also how, in each case, the loss may be reduced by proper designing.

11. (a) In what part of a pipe line should air valves and blow-offs be placed, and why? (b) In turning water into a pipe line, what precautions should be observed, and why?

12. Suppose steel pipe for a pipe line has been inspected and found to conform to specification requirements when it leaves the factory. State what inspection and tests should be made after delivery at the site of the work, during the laying, and after the completion of the laying.

13. (a) Describe first quality bell-and-spigot stoneware pipe and the defects which should be looked for in inspecting it. (b) Explain fully how the pipe should be laid.

14. Explain how a tunnel for an aqueduct through material which would not support itself would be lined with concrete; explain fully with sketches.

15. Give a longitudinal section and a cross-section of a syphon culvert for carrying a stream under an aqueduct.

MATHEMATICS.—1. A rectangular reservoir is 350 ft. by 500 ft. in size on the bottom and has interior side slopes of 1½ horizontal to 1 vertical. It is 15 ft. deep to the flow line. How many gallons will it contain, there being 231 cu. ins. per gallon?

2. The radius of a circle is 33 ft.; what is the area of the inscribed hexagon?

3. What are the two values of x in the equation $x^2 - 50\,x = 399$?

4. The bottom of a steel pipe line 8 ft. in diameter is 260 ft. below the water level of the reservoir. What should be the thickness of the steel plate at that point, allowing 15,000 lbs. per sq. in. as the strength of the steel plate. Determine the size, number and spacing of the rivets in the longitudinal seam, allowing 8,000 lbs. per sq. in. shear on rivets. Figure water as weighing 62.5 lbs. per cubic foot.

5. A strut inclined 60° to the horizontal sustains a horizontal thrust of 10,000 lbs. What is the pressure along the length of the strut and what is the vertical component of the stress?

REPORT.—To show your ability to express your ideas clearly, correctly, and forcibly, write a report of not less than three pages in length on one of the following subjects:

(a) A location survey reporting on several alternate routes of aqueduct. (b) The examination and search along the line of a proposed aqueduct for material available for use in construction. (c) The investigation of an available water-supply from a drainage area. (d) Discuss the proposed construction of a syphon under the Hudson River. (e) An investigation of a site for a reservoir.

In every case describe clearly the work done and results obtained and discuss the latter, giving all reasons for the conclusions reached. Sign your report "John Doe."

Hydraulic Engineer.

The U. S. Civil Service Commission gave an examination on Feb. 16 and 17, 1910, for Hydraulic Engineer in the Water Resources Branch of the Geological Survey. The salaries for this position were given in the advertisement as ranging from $1,200 or less to $2,400 per annum, the determining factors being the character of the training and experience of the eligibles.

Training and experience were rated on the application, and candidates were not admitted to the examination if they failed to show in their applications sufficient training and experience to entitle them to a mark of at least 70% in this subject. A mark of not less than 70% was allowed to those who had been or were about to be graduated from a reputable engineering school or who had had three years of good practical field engineering service. Eligibility for appointment requires a mark of at least 60% in the written examination. The age requirement was 20 years or over.

The examination allowed seven consecutive hours on each day. The subjects, estimated time required, and relative weights are shown in the following table:

Subject.	Estimated hours required.	Relative weights.
First day:		
1. Mathematics	2	1
2. Plane surveying	2½	1
3. Irrigation engineering	2½	2
Second day:		
4. River hydraulics	3½	3
5. Water power engineering	3½	3
Training and experience	...	10
	14	20

The candidate was in no way bound to the above estimates of time but was at perfect liberty to divide it up as he saw fit so long as he did not use more than the seven hours allotted for each day.

MATHEMATICS.—Three and only three of the following five questions were to be answered:

1. Given $\cos x = \frac{\cos y - a}{1 - a\cos y}$. What is $\tan \frac{x}{2}$ in terms of y?

2. In two unequal sized circles that touch one another externally prove that chords joining the opposite extremities of parallel diameters pass through the point of tangency.

3. Given the coordinates (5, 2), (3, −5), and (−4, 4) of the vertices of a triangle; what is the length of the radius of the inscribed circle?

4. $\mu = x\ (6 - 3x - 4x^2)$. What is the value of x for a maximum or minimum value?

5. What is the area between the curves $y^2 = 4x$ and $x = 6$?

PLANE SURVEYING.—1. The lots along the north side of a certain township contain 34.3 acres, and those along the west side 39.8 acres, except lot 4 of section 6, which contains 34 acres. Otherwise the township is perfectly regular. The following named lands are patented: All of sections 1 and 2; S. E. ¼, S. ½ of the S. W. ¼, S. ½ of the N. W. ¼, S. ½ of the N. E. ¼, lots 1, 2, 3, 4, section 4; the S. E. ¼, E. ½ of the N. W. ¼, E. ½ of the N. E. ¼, E. ½ of the S. W. ¼, lots 3, 4, 5, 6, 7, section 6. The remaining lands are vacant. Find the area of the vacant lands, sections 1 to 6, inclusive.

2. Along the course of a stream is a large tract of land susceptible to irrigation. There is not enough water to irrigate without storage. A reconnaissance shows a possible reservoir site. What facts are to be determined in order to ascertain whether a reservoir is feasible and explain methods by which these facts are determined.

3. Explain a survey along a river to determine a possible site of power or hydraulic development. State how to proceed to make such a survey.

4. State and give reasons for making the various adjustments of (a) transit; (b) level.

5. Outline a plan for a topographical survey of an area of 50 square miles, on a scale of 1 mile = 1 inch. (Answer, giving list of instruments required; state how both horizontal and vertical controls are determined; say whether stadia work is desirable; describe the inking of the final sheet; in general give enough details to enable a skilled man to produce a good map under the plan described.)

IRRIGATION ENGINEERING.—1. Define duty of water; furrow irrigation; check-levee irrigation.

2. Name and discuss the principal methods of bringing water from a stream on to the land.

3. Aside from the water supply and distribution system, what are the essential factors to be considered in an irrigation project.

4. The mean flow of a river at a point above which the drainage is 3,300 square miles is as follows:

Month.	Flow sec. ft.
January	1,830
February	1,730
March	7,540
April	4,750
May	4,930
June	8,320
July	2,710
August	922
September	904
October	3,200
November	1,880
December	1,700

At a point above which the drainage area is 2,160 square miles, a diversion is to be made for irrigation. There are ample storage facilities in the basin above, which can be developed at a low cost. Assume an evaporation loss in the reservoir of 4% and a seepage loss in 22 miles of canal equal to 8 cu. ft. per second per mile. Neglecting all other losses, calculate how much land this stream will irrigate under a duty of 30 inches.

(Supplementary information: 1 acre = 4,840 sq. yds.)

RIVER HYDRAULICS.—Answer question No. 1 and any four of the remaining five.

1. Given the following tables* of discharge measurements and gage heights; prepare (a) rating, mean velocity, and area curves; (b) rating table; (c) table of daily discharge and monthly means; (d) duration table for 0 — 1,000; 1,000 — 2,000; 2,000 — 5,000; above 5,000 sec. ft.; (e) discuss any inconsistencies which you may find in the discharge measurements.

2. Name and discuss the principal conditions which affect the run-off of a stream and its distribution.

3. How would you determine the daily discharge of a stream having a shifting channel?

4. Describe three methods of measuring stream flow. Which do you consider the most useful and why?

5. State and discuss the conditions under which the gage height may not be an index of the discharge.

6. The low water elevation of Lake Huron is 579 ft.; that of Lake Erie 571.3. It has been calculated by the Board of Engineers on Deep Waterways that if a dam were erected across Niagara River at a height sufficient to raise the level of Lake Erie 3 ft. a coincident rise of 1 ft. would occur in Lake Huron. Explain the hydraulic principle underlying this.

WATER POWER ENGINEERING.—1. A certain drainage area of 1,000 square miles yields the following mean flow:

	Sec. ft.
Lowest month	400
2nd lowest month	440
3rd " "	560
4th " "	800
5th " "	950
6th " "	1,450
7th " "	1,600
8th " "	1,830
9th " "	1,960
10th " "	2,770
11th " "	3,450
12th " "	4,220

There are ample reservoir facilities at the following costs per acre-foot:

For 1st	50,000	acre-feet	$3.50
For 2nd	50,000	"	2.80
For 3rd	50,000	"	1.90
For 4th	50,000	"	1.00
For next	100,000	"	.85
For next	100,000	"	.60

There are alternate power propositions as follows:

(a) At a point on the river above which the drainage area is 1,000 square miles, there is available a net fall of 30 ft. where a plant can be built of 4,360 HP. capacity, costing $100 per horsepower exclusive of reservoir costs.

(b) At a point above which the drainage area is 500 square miles, sufficient water can be diverted through a canal 3.5 miles long, to a point where the net head of 350 ft. can be developed to produce 4,360 HP. at $100 per horsepower exclusive of reservoir costs.

Discuss these propositions, showing which is the preferable plant and give full reasons why you arrive at your opinion; neglect consideration of costs of maintenance and operation.

(Supplementary data: 1 sec. ft. per day = 2 acre-feet; 1 acre = 43,560 sq. ft.; horsepower calculated at 80% efficiency on the wheels.)

*The first of these two tables, omitted for lack of space, gave nine measurements extending over a period of eight months, from February to September. Each measurement included the width, section area, mean velocity, gage height and discharge in cu. ft. per sec. The second table gave the gage height for each day of the month of April.—Ed.

2. (a) Describe two types of hydraulic motors and the conditions under which each is used. (b) What is a draft tube and what is its utility? (c) Describe the process of rating turbines. (d) What are the principal sources of loss of efficiency in turbines?

3. Name and describe in 1,000 words or less, any water power plant with which you have been connected or which you have studied (stating which), giving all necessary details as to the various parts.

(The rating of this thesis will depend quite as much on the comprehensiveness of your description as on your accuracy as to precise details.)

4. In the course of a large river there is a rapid 2 miles long with a total fall of 30 ft. The promoters of a water-power development at that site are in doubt whether it is better to develop by diversion through a canal from head to foot of rapid or by erecting a high dam at the foot. Assuming that you were called in consultation in this case, discuss the conditions and the process by which you would render an opinion. You may assume any set of conditions that you may choose as a basis for your statement.

5. (a) What is load factor? (b) Discuss the factors which determine whether or not a power plant development will pay.

Transitman.

The examination for transitman, New York City service, was held in two sections on two consecutive days, owing to the large number of applications received for examination.

FIRST DAY, TECHNICAL.—1. In taking equal sights with a transit, what instrumental errors are compensating, and under what conditions?

2. In what ways may errors be made in reading an angle?

3. What is the difference between a traverse table and a table of natural sines and cosines?

4. What are the sources of error in line measurement and the means of minimizing them?

5. What objections are there to an angle of 10° or less in triangulation?

6. What examination of a boundary survey should be made to discover errors?

7. Show by sketch a vernier on a transit limb and explain how you are able to read to minutes and half minutes.

8. Define parallax; what causes it and how is it overcome?

9. Suppose the horizontal axis of the telescope to be not exactly at right angles to the vertical axis; what would be the effect in work done and how would you correct it?

10. What are the causes of errors in taking long sights, and how may they be minimized?

11. Describe the method of getting the true meridian.

12. How would you join two lines by a simple curve? Show your notes.

13. Describe the making of a stadia survey, including all preliminary surveying before taking stadia sights.

14. How would you determine the distance between two inaccessible points?

15. When long sights are necessary (of over 20 miles), what are two methods of taking them?

FIRST DAY, MATHEMATICS.—Answer any five, and only five, of the following questions:

1. In 1859 a certain line had a magnetic bearing of N. 21° 00′ W. The declination of the needle at the place was then 8° 39′ W. In 1902 the declination had changed to 10° 58′ W. What should be the magnetic bearing of the line in 1902?

2. A 10° curve is being laid out from one of the points of tangency by deflection angles in 100-ft. lengths. The exterior angle between the tangents is 43° 20′. How long is the curve?

3. The bearing of one side of a field in the shape of an equilateral triangle was N. 7° 45′ E. Find the bearings of the other sides taken in order around the field. Find also the azimuths of the sides.

4. The coordinates of four points of a survey, A, B, C, and D, are: 75 N. and 68.52 E. for point A; 97 S. and 74.3 E. for point B; 51.6 N. and 74.3 W. for point C, and 75 N. and 169.48 W. Find the bearing and distance of the line AD and of the line CB.

5. Perform the following operations by the use of logarithms: Take the cube root of 7.321.2, multiply it by 0.08462, and then divide that by 3. Attach the proper characteristic to the mantissa of the final result, showing the logarithm of the answer.
The mantissa for 73212 is .8645822710.
The mantissa for 3 is .4771212547.
The mantissa for 8462 is .9274730210.

6. The double meridian distances (or double longitudes) and the balanced latitudes of certain traverse courses of a field are given below. Compute the area of the tract in acres and decimals to one place:

Course.	D. M. D.	Lat.
1	106.1	+352.00
2	266.1	—206.00
3	116.4	—109.00
4	43.6	— 37.00

SECOND DAY, TECHNICAL.—1. Describe the method of locating a curve joining two tangents when the point of intersection is inaccessible.

2. Describe a plane table and its use.

3. Show by sketch the principle of stadia surveying and derive the formula for exact work.

4. Describe the method of measuring a base line for an accurate triangulation survey.

5. How would you survey a reservoir and calculate its capacity?

6. Explain the method of examining and adjusting the angles of a closed boundary survey.

7. Show the form of table for balancing a survey, and explain the process.

8. How do logarithms facilitate calculations? (b) Give the rule for finding the characteristic.

9. (a) What parts must be given in order to solve a plane triangle? (b) State the different cases that may arise. (c) Which case has more than one solution?

10. State the adjustments of a transit in their proper order (description not called for), and describe the adjustment of the long bubble frequently attached below the telescope.

11. Define the following terms: (a) Natural sine; (b) inversely as the square; (c) normal; (d) equation of condition.

12. Why is a small angle undesirable in the use of a transit?

13. How would you proceed to locate an irregular shore line?

14. Describe the making of a quick topographical survey of an area of about 20 acres of country property proposed to be taken for a park.

15. What are the difficulties of running a transit line in the city, and how are they overcome?

SECOND DAY, MATHEMATICS.—Answer any five, and only five, of the following questions:

1. Practically the same as question No. 4, first day.

2. A line is run on an up-grade of 2% for 650 ft. from point A to a point B. Thence a level line is run for 360 ft. to a point C. Thence on a down-grade at the rate of 70.4 ft. to the mile for a distance of 1,380 ft. The elevation of A is 62.3 ft. above the given datum plane. What is the elevation of the point D?

3. The following bearings were observed with a compass: AB = N. 27° 30′ E., BA = S. 25° 15′ W., BC = S. 88° W., CB = N. 87° 45′ E., CD = N. 47° 15′ W., DC = S. 47° 15′ W. Where did the local attraction occur? Find the correct bearing of each course.

4. Find the area in square feet enclosed by the surveyed line and the irregular boundary of a field as shown by the following offsets: At station 0 + 0, 13 ft.; at 0 + 20, 18 ft.; at 0 + 60, 24 ft.; at 0 + 82, 18 ft.; at 0 + 95, 23 ft.; at 1 + 10, 43 ft.; at 1 + 28, 31 ft.; at 1 + 50, 38 ft.; at 1 + 90, 17 ft.; at 2 + 20, 28 ft., and 2 + 40, 28 ft.

5. Similar to question No. 6, first day.

6. Practically the same as question No. 5, first day.

Standard Specifications for Underground Construction Adopted by the City of Seattle, Washington.

By H. L. ESTEP.*

The need of regulating the traffic on city streets so as to avoid congestion in the crowded district is apparent and has been given much study with beneficial results. There is, however, another kind of congestion, beneath the surface, which presents, if anything, more serious though less obvious problems. In addition to a city's water and sewerage systems, space must be found under the pavement, for gas and steam mains, for telephone and telegraph wires and for electric light and power conduits. In some cities underground refrigerating systems are also being installed.

*310½ East Mercer St., Seattle, Wash.

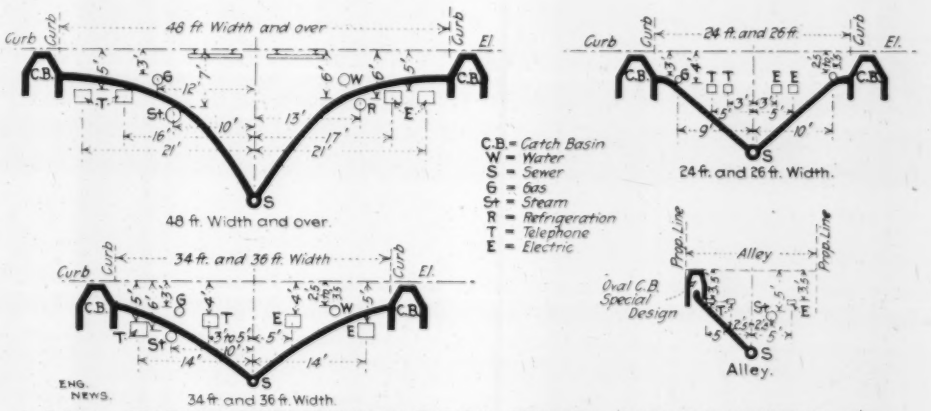

FIG. 1. SECTIONS OF ROADWAY IN TYPICAL STREETS, SHOWING LOCATION OF UNDERGROUND SYSTEMS.

Seattle has experienced these difficulties and the rapid growth of the city and its extensive regrade work have increased them. Recognizing the need for some general plan to guide this underground construction, the Department of Public Utilities has prepared standard plans and specifications designed to regulate the location of subsurface construction, the methods to be pursued in executing the work and the material to be used in it. The specifications, particularly as regards the location of the various conduits and pipes are unusually complete and explicit. Mr. P. P. Whitham, Field Assistant Superintendent of Public Utilities, originated and has charge of the drawing up of the specifications, under the direction of Mr. A. L. Valentine, Superintendent of the department.

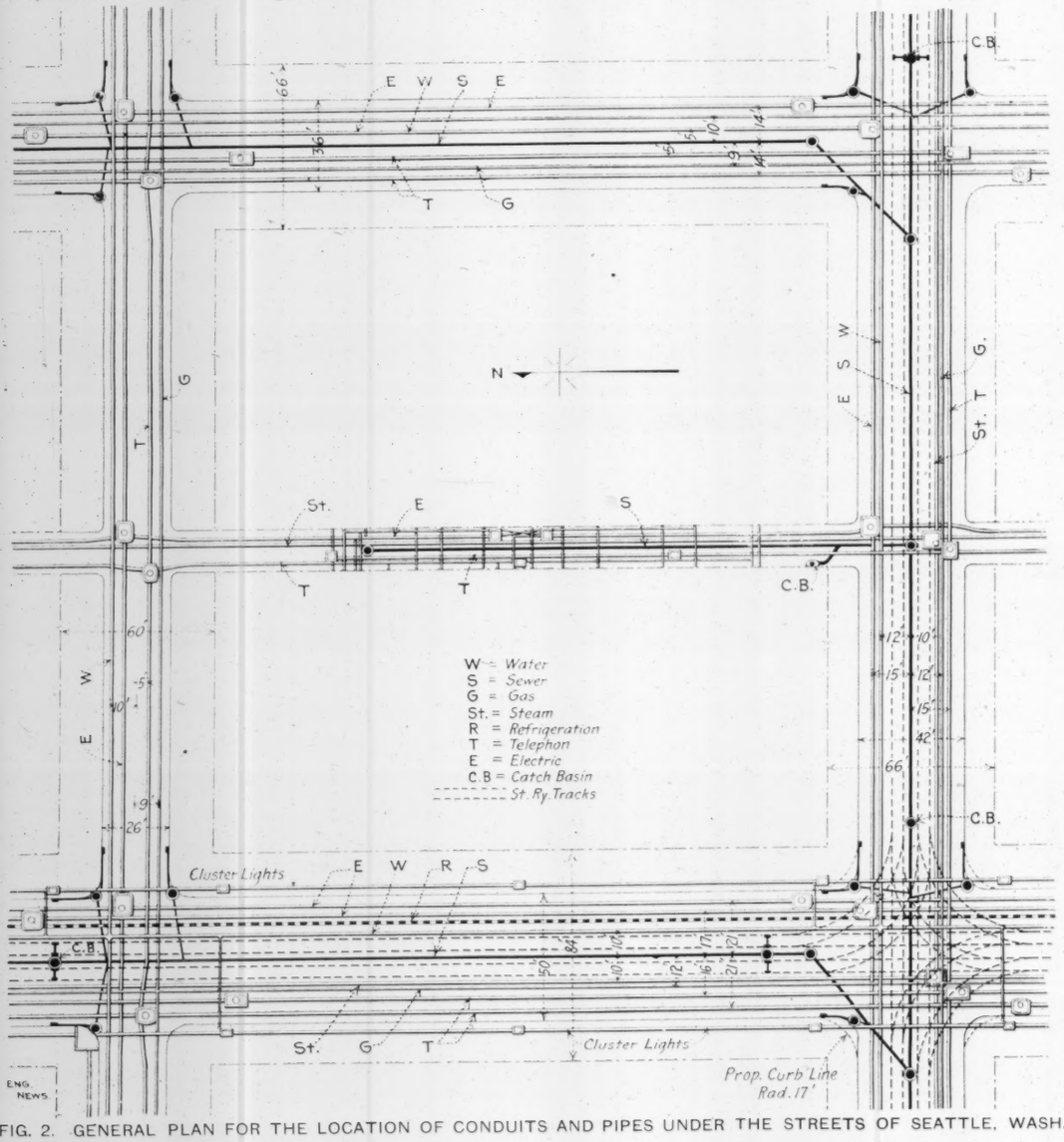

FIG. 2. GENERAL PLAN FOR THE LOCATION OF CONDUITS AND PIPES UNDER THE STREETS OF SEATTLE, WASH.

The Department of Public Utilities, while not an institution peculiar to Seattle, has an unusually effective organization in that city. The franchises of the public service corporations put the control of their underground construction work into the hands of this department and it is making able efforts to systematize the work—something which, so far as could be learned, none other of the larger cities of the United States has as yet attempted. Under the old system the companies themselves, as a rule, have had no exact records of the location of their own sub-surface work and a great deal of unnecessary expense is entailed wherever repairs or extensions are to be made. Pavements and parking strips are torn up unnecessarily and valuable time is wasted. It is hoped through the operation of the new system, devised by the Public Utilities Department and adopted Jan. 4 by the Board of Public Works, that these evils can be eradicated and also that the maximum use may be obtained of the limited space below the streets, for it is emphasized, in the specifications for laying the ducts, that as little vertical space as possible be taken up. Under the new plan any company putting in an application for a permit to do new work can be assigned at once a definite location for the proposed construction. The cost to the company and to the city will thus be reduced. Through standardizing the materials to be used, the cost of municipal pipes and conduits will also be lessened.

A comparatively recent ordinance which originated in the Department of Public Utilities and which was passed by the City Council of Seattle in August last, increased the need of standard specifications for underground construction. The ordinance provides that within three years from the date of its passage (August 2, 1909) all electric-service, telephone and telegraph lines in the business portion of the city shall be placed underground. This district is roughly bounded by Jackson St. on the south, Fourth Ave. on the east, Cedar St. on the north and Western Ave. and Post Alley on the west, and comprises about 87 blocks. The limits of the district will be extended as necessity demands, and as the regrade work permits.

The first portion of the specification for underground construction provides rules and regulations applying to the work in general. It is specified that trenching shall not be carried on in more than two consecutive blocks at one time; tunnelling under pavements, except under car tracks, is forbidden and the streets must be restored to their original condition at the conclusion of the work. It is also provided that applications for permits to open up the street shall, when submitted to the Superintendent of Streets and Sewers, be accompanied by a sketch or map, drawn to a scale of not greater than 100 ft. to the inch, showing the location and nature of the projected repairs or services. This sketch must have the approval of the Superintendent of Public Utilities.

TABLE I.—STANDARD LOCATION OF UNDERGROUND WORK, SEATTLE, WASH.

Width of Roadway.	Location of Conduit or Pipe.
TELEPHONE AND TELEGRAPH CONDUITS.	
18 to 20 ft.	3 ft. S. or W. of center line of roadway.
22 to 32 ft.	3 to 5 ft. S. or W. of center line of roadway.
34 to 40 ft.	3 to 5 ft. or 14 ft. S. or W. of center line of roadway.
40 to (car line)	15 ft. or 18 ft. S. or W. of center line of roadway.
42 to 46 ft.	15 ft. or 18 ft. S. or W. of center line of roadway.
48 and over.	16 to 21 ft. S. or W. of center line of roadway.
ELECTRIC LIGHT & POWER CONDUITS.	
18 to 20 ft.	3 ft. N. or E. of center line of roadway.
22 to 32 ft.	3 ft. or 5 ft. n. or E. of center line of roadway.
34 to 40 ft.	5 ft. or 15 ft. n. or E. of center line of roadway.
40 to (car line)	15 ft. or 18 ft. N. or E. of center line of roadway.
42 to 46 ft.	15 ft. or 18 ft. N. or E. of center line of roadway.
48 and over.	17 ft. or 21 ft. N. or E. of center line of roadway.
GAS MAINS	
28 to 22 ft.	6 ft. S. or W. of center line of roadway.
24 to 40 ft.	9 ft. S. or W. of center line of roadway.
40 ft. (car line)	12 ft. S. or W. of center line of roadway.
42 ft. and over.	12 ft. S. or W. of center line of roadway.

TABLE II.—RELATIVE DEPTHS OF SYSTEMS OF CONDUITS AND MAINS, SEATTLE, WASH.

Service.	In General.	In Outlying Districts.	In Alleys.
Telephone and Telegraph.	(5 ft. (4 ft. between street intersections)	4 ft. (3½ ft. between street intersections)	3½ ft.
Electric Light and Power.	5 ft.	4 ft.	3½ ft.
Gas	2½ to 3½ ft.	....	....
Steam and Power.	6 ft.	6 ft.	5 ft.

The specifications provide in detail for the location of underground construction. Telephone and telegraph conduits, gas and steam mains are all located on the south or west side of the street; electric-light and power cables and refrigeration lines are laid on the north or east side. The detailed locations of telephone and telegraph conduits are given in Table I. Where there is a choice of location the preference is to be given to the one nearest the curb. In alleys the conduits are to be located on lines from 2½ to 5 ft. from the center line of the alley and in case of two telephone conduits they are to be placed on the same side of the alley. Provision is made for two telephone systems, two telegraph and messenger systems and the city fire-alarm telegraph. At street intersections, the conduits must have not less than 5 ft. of cover and between intersections not less than 4 ft. cover, except in outlying or residence districts where not less than a 1-ft. cover may be used at street intersections and not less than a 3½-ft. cover between intersections. In purely residence districts, where conduits are not more than 12 ins. thick or 10 ins. wide, a 26-in. cover may be used. In alleys the tops of the conduits must have not less than a 3½-ft. cover.

The city of Seattle has a municipal electric-light and power system paralleling that of the private corporation. The city has also a separate system of conduits, in the business section of town, serving the cluster lights on either side of the street. The provisions applying to the location of these and the private systems are shown in Table I. The electric-light and power

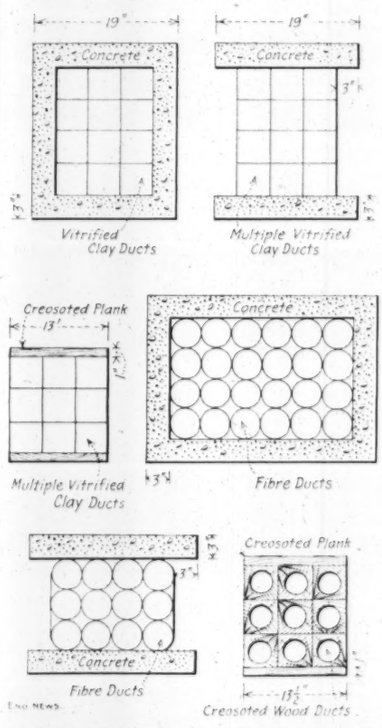

Fig. 3. Conduit Sections Showing Approved Methods of Protection; Department of Public Utilities, Seattle, Wash.

wires are thus located on the opposite side of the roadway (or alley) from the telephone and telegraph wires. In alleys the conduits are to be placed on a line 5 ft. from the center line of the alley. Along or across streets the ducts must have not less than a 5-ft. cover, except in outlying or residence districts, where not less than a 4-ft. cover may be used. The tops of the conduits are to have not less than 3½-ft. cover in alleys.

The requirements for gas mains locate them as in Table I.

Along or across streets the top of the mains must have not less than a 2½-ft. cover—preferably 3-ft.

The specifications for the steam heat and power mains depend in part on the above location of the gas mains and read:

> In streets with roadways of 34 ft. width, or more, and where the gas mains are located on the 9-ft. line, steam mains shall be located on a line 5 ft. south or west of the center line of the roadway, unless said location is occupied, in which case on the line 10 ft. south and west of the center line of the roadway.
>
> Steam mains in alleys shall be located on a line 2½ ft. from the center line of the alley and on the side opposite that occupied by or proposed for location of telephone and telegraph conduits.
>
> Along and across the streets the tops of steam mains shall have not less than a 6-ft. cover, in alleys not less than a 5-ft. cover.

By referring to Table II. an idea of the relation of the different planes in which these several systems of mains and conduits are arranged can be obtained at a glance. Fig. 2 shows in plan the location of the mains and conduits provided for in the specifications and gives, as well, the location of the city water and sewer mains which, although they do not come under the jurisdiction of the Public Utilities Department, are included in the general plan for standardizing the underground construction work. Fig. 1 shows also the detail of the arrangements for the various widths of roadways.

Throughout the specifications allowance is made for the possible presence of obstacles or obstructions which may prevent an exact following of the plan of location as outlined, and in that event the approval of the Superintendent of Public Utilities is necessary for any variation from the prescribed location.

In addition to the specifications covering the location of conduits and mains, general provision is made for the location of the laterals or service connections. They are to be run across the street as nearly as possible at right angles to the center line of the roadway. In no instance may the angle be less than 45°. Where the angle would be less than 45° it is required that the lateral shall be located along the line of conduit, or in the event that the conduit is not constructed, on a line 1-ft. to either side of the line specified for conduits. It is further required that the radius for making the turn from the line of conduit into a pole or other connection desired, shall not exceed 6 ft. The covers for laterals not exceeding 1 ft. in thickness, nor 10 ins. in width, are to be 26 ins. in streets and 24 ins. in alleys. These dimensions are taken as the maximum for laterals, any ducts exceeding them in size being considered conduits.

Service pipes for gas may slope from the curb to the mains, but must be laid at least 18 ins. below the top of the curb and must have a depth of cover of not more than 2½ ft. across the line reserved for water mains, that is, the line 10 or 12 ft. north or east of the center of the roadway.

Steam service connections must have the same cover as the main from which they are run, with only sufficient rise for proper return drainage.

The requirements for the location and size of manholes (and hand holes) are practically identical for all types of service listed above. The size, while governed by the size of the conduits or pipes to which they give access, is limited to not more than 8 ft. for the greatest inside dimension at street intersections; not more than 6 ft. at alley intersections, unless not more than 3 ft. of the manhole lies within the marginal lines of the alley produced. The thickness of the walls of manholes is also prescribed; in streets, the walls must not be more than 13 ins. thick, if of brick, nor more than 10 ins. thick if of concrete. Similar dimensions for manholes in alleys are 8½ ins., if of brick, and 6½ ins., if of concrete.

The general system of location is to place the manholes as nearly as practicable at the intersection of the conduits or mains, or, where there are no intersecting conduits or mains, in a line 10 ft. from the street margin. Between street intersections manholes can be located according to permits subject to the approval of the Board of Public Works. Plans are on file with the Superintendent of Public Utilities specifying the covers for manholes.

The second main division of the department's plans relates to the designated materials for all underground work, and the various methods by which the ducts or pipes are to be laid and protected. Four kinds of material are specified as permissible for ducts: (1) creosoted wood (of not less than 7 lbs. saturation), (2) iron, (3) fibre, or (4) vitrified clay. The use of the first of these is confined exclusively to outlying or residence districts.

Fibre ducts must be laid on a concrete base not less than three inches thick, and all voids around the pipes are to be filled with cement mortar; the sides and top of the conduits are then to be covered with concrete, not less than three inches thick. In outlying or residence districts the concrete side casings may be omitted provided the joints are made water tight and protected against the entrance of dirt, and provided also that the ducts are tied together with galvanized wire or some equally effective material.

Two methods are stipulated for laying vitrified clay ducts. The first method and the preferred one calls for a concrete base not less than 3 ins. thick, on which the ducts shall be laid. They must be centered and held in place by dowel pins or some equally effective and approved methods. The joints must be covered with burlap soaked in oil or hot asphaltum or they must be protected in some equally effective fashion. The introduction of concrete or mortar into the ducts must also be prevented. The sides and top shall then be encased in cement at least 3 ins. thick. In the second approved method, the concrete at the sides is omitted and the top and bottom layers are extended 3 ins. on either side. In residence districts the substitution of creosoted wood planking not less than 1 in. thick, for the top and bottom layers of cement is permitted and the side layers of cement are dispensed with. The width of the planking must not be less than the maximum width of the conduit.

The concrete in all the specifications for subsurface work is required to be:

> of such a mixture that the proportion of cement to sand and gravel shall be not less than one to eight for manholes and not less than one to twelve for conduits.

The creosoted wood ducts are to be protected, at top and bottom, by creosoted wood planking at least 1 in. thick. The iron ducts are not required to have any protection other than a coating of asphaltum tar or other protection against rust. Fig. 3 illustrates these approved methods of duct protection.

Cast-iron, "hub and spigot," gas pipe is specified for gas mains except for bridge or trestle work or where the expected settlement of the street renders the use of screw pipe advisable. The location of gates, drip-pots and such appurtenances is provided for, where required, subject to the approval of the Superintendent of Public Utilities.

A covering of standard "85%" magnesia-asbestos paper, or some similar non-conductor of heat, is required on all steam pipes, and two methods of casing the insulated pipes are prescribed; (1) in wood pipes or "logs" whose walls are at least 3 in. thick; (2) in brick conduits with walls at least 4 ins. in thickness. Tile drain pipes must be placed under all steam mains and connected with the sewerage system.

It should be noted that in Seattle the ground very rarely freezes more than 3 or 4 ins. deep, for which reason it is possible to lay the water mains near the surface. In eastern cities where the ground freezes to a depth of from 4 to 6 feet or more, it would be necessary to reverse the depth zones, placing the water mains on the bottom and the conduits on top.

The plan which Seattle has adopted is broad and comprehensive, and is so definite that no confusion can result, yet it allows enough latitude, in the way of alternative locations, so that no hardships will be wrought to any company through being obliged to comply with the regulations. The originators of the plan and engineers of wide experience in other cities, whose opinions were obtained, believe that such a system when once put into execution will save public-service corporations large sums. The municipality itself will also undoubtedly profit financially as well as in the furthering of her plans for a greater and a more beautiful Seattle.

Action of St. Louis Water on Metals and Alloys.*

By W. F. MONFORT.†

The subject matter of this paper might with equal propriety be discussed under a more general title. I have chosen to refer to all of the reactions as of local occurrence, not because they are characteristic of St. Louis water, only—in the main they are of general occurrence—but because some of the observations made are of peculiarities incident to the distribution of a partially softened water.

That the character of the water may be understood, a brief résumé of the process of treatment is given.

Water from the Mississippi River is taken at a point about 5½ miles below the mouth of the Missouri River. Treatment with sulphate of iron and lime prepares for rapid subsidence of suspended matter during the passage through six sedimentation basins, whose combined capacity is about 150,000,000 gals.—approximately two days' average consumption. From these basins the water flows to two high service stations, whence it passes to the distribution system.

The table following shows the important components, after evaporation, of a representative sample during the low water period, when the alkalinity was 120 parts per million.

Calcium carbonate	60.5
Calcium sulphate	13.9
Magnesium carbonate	55.0
Sodium chloride	34.2
Sodium sulphate	85.0
	273.0

The dissolved matter acts in two ways: First, As a supersaturated solution of calcium carbonate, it has a specific action characteristic of softened waters. It furnishes a protective coating to surfaces which it touches during the completion of the softening reactions.

It has been stated above that the city water is treated with lime. Because it is a softened water much of the calcium and magnesium present are in the form ordinarily called neutral carbonates. The softening process is completed slowly at high temperatures and at winter temperatures is incomplete even when the water passes to the distribution system. There is therefore more or less deposit in mains, laterals, and service pipes, which forms a closely adherent coating over metal surfaces. During the earlier period of softening at St. Louis the attempt was made to carry the softening effect to the limit produced by the use of a large excess of lime. The extreme thickness of deposit occurred in this period.

When chemical treatment was first installed, very high caustic alkalinity was of frequent occurrence. So far as the incomplete records of the department for this period are available, this seems to have been thought desirable, or at least unavoidable. The prime purpose of treatment was clarification. Thus in 1905, during five months, the average caustic alkalinity of water distributed was 11.9 parts per million. That the attempt to carry the softening to the limit, resulting in persistent caustic alkalinity in varying degrees, not only through the settling basins, but in the distribution system, might produce heavy incrustation throughout the city was not apparently considered. During the last four years the effort has been made to avoid caustic alkalinity, and to maintain from day to day as nearly uniform a character of water as the conditions allowed.

But even with the moderate use of lime which has been the mode during the past four years the protective coating is not wanting. In time this coating may become so abundant as to reduce small openings, and by its roughness materially increase friction in the distribution system. But for our present consideration the deposit acts in a way beneficial, so far as the life of metals in contact with it is affected.

The second general manner of action upon metals is electrolytic. It is occasioned by the behavior of pure water, accelerated by the dissolved salts of sodium, magnesium and calcium, and further accentuated by the presence of impurities or variations in composition of portions of the metals which are in contact with the water, giving rise to local galvanic couples.

The cases to be cited are the action on iron, on zinc, on alloys containing zinc, and on aluminum. These are the metals commonly or occasionally used in the distribution system; aluminum in air relief valves, for example; brasses and bronzes in meter trains; zinc in alloys and in galvanized iron; iron in mains and pipes. The only constituents of the local water not common to all supplies, which have a specific action, are those carbonates of magnesium and calcium which give a red coloration with phenolphthalein; that is, the neutral carbonates. The other constituents are common to all natural and treated waters in greater or less degree.

ACTION ON IRON.—It has been shown by Walker and by Cushman that pure iron in air-free distilled water is slightly soluble, that in the presence of dissolved oxygen the metal is oxidized, and that the presence of various carbides in steel and of minute traces of impurities in soft iron serves to create differences of potential, resulting in a more or less rapid oxidation of the metal, with pitting, tuberculation and ultimate disintegration. Now, in water such as ours, containing salts of various kinds, whose solutions are conductors of electricity—that is, electrolytes—these reactions are very much accelerated. All steels and all iron used in water-works practice carry the requisite impurities to cause the formation of local couples. And yet—notwithstanding this susceptibility of iron—there are many large installations of black iron pipe in constant use throughout the city. It may be said that in the water department iron pipe is regularly used. It is questionable if the additional cost of galvanized iron pipe and fittings secures a commensurate increase in durability over that of the cheaper, plain iron installation. The fact remains that the "red water plague" does not occur with us.

ACTION ON ZINC.—The use of galvanized iron in residential installations is general. I had occasion a year ago to refer in a paper before this association to the action of our water upon this material.

A new meter with a galvanized iron cup, subjected to unusual service during 24 days, registered 128,266 cu. ft., or 961,995 gals. Upon removing the cup at the end of this period it was found to contain a soft, adherent, yellowish-white coating, which was analyzed, and found to contain about 75% of hydrated zinc oxide, with traces of calcium and magnesium compounds. The cleaned surface showed a hard, brittle black layer about 0.01-in. thick, rich in sulphides and in carbon, overlying the cast-iron body of the cup, with only traces here and there of the original zinc coating, which had been almost entirely removed or converted in place into zinc oxide and basic carbonates. No pitting or tuberculation of the iron had taken place.

It appeared in pipes examined that the irregular coating of zinc, originally present, was converted into an extremely rough, voluminous coating of secondary product, materially diminishing the bore of the pipe, and rendering very little real service in protecting the iron surface.

Pure zinc dissolves appreciably in pure water in a brief period of time. Its tendency to dissolve—solution tension—is very great, exceeding that of iron, and very much greater than that of copper or of tin.

ACTION OF ALLOYS.—My attention has been called to the action upon certain alloys used in meter trains. Employees of the tap and meter department have shown me numerous examples of destructive action, with the remark: "In nine cases out of ten when a meter of this make fails to register, it is found that the gears have completely collapsed." The failure results apparently from a degeneration of the alloy at one or both ends of the posts or studs which bind the frame together.

Analysis showed that at least three distinct alloys were used in different working parts of the gears which gave the trouble. The posts were high in zinc; the frames contained less than one-half, and the pins and screws about one-fifth as much zinc as was in the yellow posts. In one extreme case of failure these high zinc posts had been converted into a porous mass, adherent, but so weakened that the whole crumbled under pressure of the fingers. There was one gear in particular from which one post was powdered in a mortar. Under a microscope the particles had the appearance of spongy copper interspersed with greenish and almost white particles. Analysis showed the absence of zinc and the presence of 92.9% copper and 1.09% tin. The appearance of the metal remaining in the posts suggested that local action had resulted in the wasting of zinc.

Once the removal of zinc is begun, the process must go on to completion. For a high zinc alloy in contact with copper gives up its zinc rapidly and with increasing speed. It is only necessary, therefore, that the saline content of the water be great enough to invite the reaction. Thereafter a minimum concentration suffices for its continuance until the yellow alloy is degraded.

Usually the parts are weakened at the points of contact long before the middle of the posts are seriously affected, with the resulting break commonly coming at one or both of the screws which hold the frame together.

Looking at the facts in the light of the demonstration which the foregoing experimentation has outlined, further explanation is not demanded. The zinc of the yellow alloy has pushed into solution to escape from a condition of unequal tension which the manufacturers have unconsciously brought about. In the progress toward equilibrium a worse state has arisen, culminating in a breakdown of the mechanism.

The attempt made a year ago by the manufacturers of this particular meter to obviate the difficulty by tinning the wheels is of no avail. Tin does not protect iron even; much less does it protect zinc.

The solution of the difficulty lies in eliminating high zinc alloys and using one alloy throughout the train, frame, posts, and case, making it after the order of the "one-horse shay." With alloys of equal potential there will be some local action; both copper and zinc actually waste from an alloy at the same time in salt solutions, as my experiments show; but the resulting weakness will be better distributed, making the life of the meter longer.

This trouble is not confined to one locality. It has occurred at points other than St. Louis. With waters containing high percentages of saline constituents such as abound in the Western States it is impossible that this electrolytic action should not be wide spread. It must occur wherever alloys of high and low zinc are used in meters in such waters.

ACTION ON ALUMINUM.—My attention was called to the deterioration of aluminum in some air relief valves used in the department. Some of the parts were of aluminum in contact with brass. After a time the white metal was found coated over with hydroxide, and deeply corroded. The result was natural, but the manufacturers seem not to have taken into account the behavior of different metals in contact. In the light of some experimental facts developed later, there could have been no avoidance of the trouble with untreated or with softened water in contact with commercial aluminum alone.

With distilled water containing so little as 13 parts per million calcium carbonate, or 35 parts per million sodium chloride, or with a solution of these two components in these amounts, hydrogen is evolved in measurable quantities by commercial aluminum, while the surface of the metal is covered over with a film of hydroxide, save where strong centers of local action occur. Eventually the action in still water becomes very slow by reason of this protective coating, resembling an enamel in appearance; but in running water pitting is very severe and prolonged.

SUMMARY.—The water supply of St. Louis by reason of its content of neutral carbonates exerts a two-fold effect during distribution:

1. Physical. A protective coating forms on surfaces exposed.

2. Chemical. Specific action of hydroxyl ions largely inhibits the corrosion of iron.

The dissolved saline matter increases the conductivity of the solution, and thereby accelerates electrolytic action.

The waste of zinc under these conditions is quite rapid. Zinc, even in alloys, possesses a high solution tension, giving rise to marked differences of potential between alloys of different zinc content.

This can be demonstrated by the use of agar jelly containing phenolphthalein with alloys of different zinc percentages.

For this reason zinc alloys of widely different composition suffer marked deterioration when combined in systems exposed to such strongly saline water, by the wasting of the constituent of highest solution tension.

Such waste is not inhibited by partial tinning of surfaces.

Commercial aluminum reacts too readily with even moderately saline waters to warrant its exposure in working parts.

It is important that, so far as possible, only homogeneous materials be placed in contact in such a water.

*Condensed from a paper read before the American Water-Works Association at New Orleans, La., April 29, 1910.

†Chemist, City Water-Works, St. Louis, Mo.

THE PHYSIOLOGICAL EFFECT of an alternating magnetic field has recently been studied by Prof. S. P. Thompson and is discussed in a paper before the Royal Society of London, April 14. It appears that Prof. Thompson made a coil large enough to admit a person's head and having 32 turns of stranded wire through which up to 180 amps. could be put.

On placing the head in the coil with alternating current flowing, in the dark or with the eyes closed a faint flickering light is perceived. The intensity of the luminous sensation is not the same in all parts of the luminous field and the period of the flicker is not well defined. The effect is increased by increasing the intensity of the magnetic field. No effect is noted on the senses of smell or hearing, but there is an effect upon the taste. By some it is believed that all these effects are from currents induced in the blood vessels and nerves rather than of the magnetic field directly.

TESTS OF THE WEATHERING OF COAL, to determine the loss in heat value by exposure, have been made by Prof. S. W. Parr and Mr. W. F. Wheeler at the Engineering Experiment Station of the University of Illinois. The tests are described in Bulletin No. 38, just issued by the Station. The authors review the researches of various experimenters who give percentages of loss due to weathering running up as high as 25%. This is contradicted by other experimenters who find very little loss. The tests made by Messrs. Parr and Wheeler indicate that Illinois coal suffers very little loss in calorific power by storage, amounting probably to not over 3½% as a maximum for coal stored a year. The chief damage which the coal suffers from storage is in the breakage, so that an undue percentage of dust and fine particles is formed. This, of course, does not include losses which may occur due to fires caused by spontaneous combustion. Such fires, and the breaking up of the coal into small particles, appear to be the chief objections to the storage of large quantities of coal for a long time.

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There are various ways of viewing the "stipulations and contract" governing the discharge of treated sewage into New York Harbor which have recently been agreed to by the Passaic Valley Sewerage Commission and the United States.

We are inclined to think that the general government has been unwise in attempting to prescribe both the results to be attained by the works and the character and extent of the works that are to attain that result. Such a stipulation always tends to relieve the party doing the work of responsibility as to the results attained. It is usually far better for both parties to leave the means of accomplishing the agreed end to the party which has to do the work. Such a course, in the present instance, would have freed the United States, on the one hand, of any question of responsibility for results through having itself prescribed or agreed to the means of achieving them; and, on the other hand, it would have given the Commission a perfectly free hand in designing and operating its treatment works, enabling it to utilize and to adapt to local conditions any of the various means of sewage treatment which seemed most likely to achieve the results called for by the contract. At the same time it may prove to be in some respects advantageous to the Commission to have the contract state just what kind and capacity of works it shall build.

A reference to the stipulation published elsewhere in this issue will show that the Commission is tied down to a single method of treatment, namely, screening and sedimentation, and that the mesh of the screens, the dimensions of the settling tanks, their holding capacity, detention period, and the lineal rate of flow through them are all laid down in definite figures. Who knows whether either the exact method of treatment prescribed or the details of the tanks as laid down are best suited for the sewage of such an aggregation of diverse communities as is comprised in this sewerage district? The sewage of the various communities has yet to be brought together in a common outfall sewer before any one can ascertain its exact composition or the effect of the treatment proposed. Even before the treatment works are ready for use there may be new developments in sewage treatment which will profoundly affect the design and operation of works. The longer the works are in operation the greater the chances that the conditions just named will arise. Yet the Commission is tied down to one particular combination, capacity, etc., of apparatus and to one way of operation.

Quite another way of looking at the agreement is this: The Commission had submitted to the War Department a quite indefinite scheme of screening and sedimentation and had offered to satisfy any requirements the Department might lay down. The stipulation substitutes a definite for an indefinite scheme of screening and sedimentation and formulates the results which the works must achieve. The Commission is therefore relieved in large measure of responsibility for the character and extent of its works, and, as we have already stated, for the results attained by the works. Doubtless the representatives of the United States believe that the Commission is bound to achieve the results laid down in the agreement, even if the character of the works is defined, but how the matter would be regarded by experts and judges if it came before our highest courts for interpretation is another matter. Moreover, while the Commission would doubtless have been better pleased with fewer and less exacting restrictions it may perhaps congratulate itself that no higher nor more definite standards are exacted, particularly in view of the talk which has been indulged in by some parties regarding the dangers of admitting the Passaic Valley sewage unless purified to a high degree.

All parties concerned are to be congratulated for having settled this lawsuit by private agreement rather than by trial, although there would have been decided advantages in a clear-cut decision of the U. S. Supreme Court on the points in controversy—if a decision could be obtained that did not dodge the main issues, as was done in the Chicago Drainage Canal Case.

Finally, the country at large is to be congratulated on the outcome of the suit, because the compromise effected includes a recognition by the legal department of the U. S. Government that sewage disposal by dilution, after screening and a brief period of sedimentation, may be legitimate and rational where conditions are favorable to it. It is only a step further, and a logical one, to recognize the fact long recognized abroad and always tacitly recognized here, that in many instances sole reliance may be placed on disposal by dilution.

The Passaic Valley Sewerage Commission and its engineers based its designs on the assumption that disposal by dilution, with a moderate amount of preliminary treatment, would be sufficient. The compromise brings the designs for preliminary works proposed by the Commission into a more definite form, and associates with them what are ostensibly definite requirements as to results to be attained, but what in reality are for the most part a series of rather vague general stipulations, with no standards to conform to and no specific provision for settling any differences of opinion that may arise between the two parties as to whether or not the requirements are being fulfilled. While as a rule we deprecate such vagueness of stipulation and such lack of provision of means for settling disputes which may arise over interpretations and results, yet in this particular case we think little real injury to anyone will result.

We particularly commend to all our readers interested in any phase of engineering education the remarkable paper by Prof. Geo. F. Swain, delivered as an address at Union University at the recent opening of a new engineering building there. We believe this to be the ablest and most fruitful discussion of engineering education that has appeared in a very long time. Prof. Swain is competent both by ability and experience to treat this subject as very few men are. He is not only among the foremost workers in the teaching of engineering but he has had notable experience as an engineer in connection with some of the most important enterprises carried on in Massachusetts during the past score of years.

Moreover, Prof. Swain's paper is broader even than its title indicates. The principles laid down are almost as applicable to higher education in general as they are to the education of engineers.

Particularly would we commend Prof. Swain's paper to the many students among our readers. We strongly advise them not only to read it but to carefully study it. Thousands of students are asking to-day whether the college education—be it in engineering, or in the so-called "culture courses"—is worth while. Prof. Swain shows how such an education can be made very well worth while as well as the reasons why the time spent by many in college is often worse than wasted.

Prof. Swain's fearless criticism of current methods of teaching and administration in our colleges ought to be carefully read by every instructor as well as by those responsible for the administration of our colleges. Nowhere have the defects of methods still too common been more clearly exposed. Nowhere have the proper methods for instruction and organization been more admirably stated.

We are very glad to have the privilege, through the courtesy of the authorities of Union University, of giving the first publication to Prof. Swain's address.

Comparisons of water rates in various cities and particularly comparisons of rates charged by publicly-owned and privately-owned plants, are worse than worthless unless accompanied by more local-condition data than are generally available. This fact was made apparent many times during the recent convention of the American Water-Works Association, at New Orleans, reported in our last issue.

A generally-overlooked factor in comparing the water rates of two or more cities is the division of the cost of the total water service between the city at large, as reflected in the general tax levy, and private consumers, as shown by fixture and meter rates. There are wide variations in this respect, and these variations occur under both private and public ownership, though generally more clear in the case of private works. In the case of private companies it is easy to determine broadly whether or not there is a mere nominal charge for water supplied for public purposes or a substantial levy to meet the cost of the service. Obviously, the balance of the gross revenue, be it large or small, comes from the private consumer. But, with few exceptions, who can tell without months of work by engineers and expert accountants, how the total cost of water under municipal ownership is divided between the water-rate payer and the city tax-rate payer? Generally speaking, the municipally-owned plant is given no credit for water supplied to other departments.

This may or may not mean that the water rates for private service include the cost of public service as well. By one means or another, in the present or in the past, a considerable portion of the capital outlay as well as the operating expenses may fall or have fallen on the taxpayer as distinct from the water consumer. Under such conditions, unless understood, low private rates are a delusion: always for comparison with other cities; often to the individual water consumer and taxpayer.

It is well known that a large part of the investment in any water-works system is the cost of the distribution mains. A few important cities in the Central West and Northwest, including Chicago, Minneapolis and St. Paul, assess the cost of ordinary mains on the abutting property. The result is a material decrease in capital charges, which makes possible low rates with apparent profit. This may or may not be justifiable as a matter of public policy; but there can be no question as the unfairness of an unqualified comparison of the water rates in such a city with those in which the practice is to make the water rates high enough to cover all water-main extensions from year to year. It will be seen that in one instance the property owner and in the other the water consumer pays for extending water mains; and that while the property owner

pays once and is done with it, the water consumer never ceases paying.

There is another important phase of this subject. Water companies *must* collect revenue to cover all operating and capital charges. Cities rarely consider capital charges, beyond interest on outstanding bonds. Oftentimes the bonds outstanding on municipal works are but a small percentage of the total bond issue. A notable instance is Milwaukee, Wis., whose water-works debt is practically all paid off. The city supplies water to all consumers, large and small, at 6 cts. per 1,000 gals., and has no minimum charge. Even at this low figure the water department shows an apparent profit. This may be a just source of pride for Milwaukee, but the figures have absolutely no bearing on questions of water rates and profits elsewhere. Moreover, without engineering and accounting analysis of the financial history and present status of the Milwaukee works, we have no guarantee that they have not been and are not now being operated at a loss, making proper allowance for capital charges. Of course the contrary may be true, but even if it is, that is no proof that the municipal works at Cincinnati or the private works at San Francisco could possibly supply water at 6 cts. and show a balance on the right side of the ledger.

The only fair basis of comparison of either water rates or profits is the cost of the supply per 1,000 gals. furnished, including operation, maintenance and capital charges, and not forgetting depreciation. Even so, the comparison will be unfair unless the service rendered is substantially similar in character: that is, quality, quantity in relation to legitimate needs, pressure, etc., must be substantially the same in the places compared or else additions to or deductions from the cost of service must be made. One city may show a low cost per unit quantity supplied, but the water may be so impure as to cost the community hundreds of thousands of dollars of outlay for typhoid fever, while the pressure may be so low as to entail heavy extra fire department charges, extra insurance rates and heavy fire losses and outlay for pumping by private consumers. As regards quality it was stated at the water-works convention that a man who was boasting of his low meter rate admitted on being questioned that he paid $36 a year for bottled water.

Finally, most of our cities and water companies alike should quit comparisons of rates and costs until they have revised their accounting systems and taken all the cost elements into consideration. To make their financial results comparable even then, it will be necessary to agree on some plan of uniform accounting. To that end they may well give careful consideration to the schedules of the Committee on Uniform Accounts and Reports of the American Water Works Association and of the U. S. Bureau of the Census. The two schedules are identical in most respects and it seems likely that they will be made entirely so. The Census schedule in an earlier form has already been used in collecting information for the yearly Census bulletin, "Social Statistics of Cities," and as all cities of 30,000 and upwards owning water-works are frequently called upon to supply information in accordance with the Census schedule, it will be to their convenience to adapt their accounts to the schedule as opportunity arises; at the same time they will aid the good cause of improved water-works service and economy.

One of the most pressing municipal problems of the day is the sanitary protection of the public milk supply. It is fairly well known that milk serves as a vehicle for typhoid infection, but comparatively few realize that it spreads scarlet fever and diphtheria as well. Still fewer are aware that in the opinion of many of the most eminent sanitarians milk is one of the chief means of infecting infants and young children, and perhaps, after a long series of years, adults as well, with tuberculosis or consumption. In addition to infection with pathogenic germs all dirty milk (and most city market milk is very dirty) abounds with bacteria which cause changes in its chemical composition which give rise to toxic and other products very harmful to infants, young children and invalids on a milk diet.

The foregoing facts, combined with physical and economic conditions which affect the production, transportation and sale or delivery of milk to consumers, give rise to some difficult problems. Briefly, they center in the question, shall milk be kept free from pathogenic infection and from dirt, and shall its temperature be kept at 50° or below from the time the milk is produced until it is delivered to the consumer, or shall there be a minimum of effort in this direction and a concentration of endeavor on efficient pasteurization of the milk, with its attendant killing of nearly all its germ content, pathogenic or otherwise?

The answer, which really involves a consideration of many subsidiary questions, must depend largely upon local conditions. It goes without saying that nearly everyone would prefer a supply kept safe through cleanliness and sanitary protection to one made safe through pasteurization after having been fouled and possibly infected by dirtiness and carelessness. There are some communities, which, because of their relatively small size, favorable surrounding conditions for the production of clean, non-infected milk, general intelligence and discrimination of the milk-consuming public and high efficiency of their health departments, can secure a milk supply which is non-infected; there are other communities which are so large or so backward that they may have to content themselves with a disinfected dirty milk—and perhaps consider themselves fortunate at that.

The city that depends upon regulation and inspection for a pure milk supply may of course suffer from the inadequacy of the latter. Likewise the city that depends on disinfection, or pasteurization, may suffer because the work is imperfectly done; but this is not all, for it is generally admitted that the pasteurization must be done in the city, and not at the dairies in the country. Consequently, the milk is 24 to 48 hours or more old before it is pasteurized, and may contain the toxic products of millions of bacteria per cubic centimeter, which products are not affected by pasteurization. Moreover, pasteurization, which is a remedy for dirt, carelessness and general defiance of the laws of sanitary milk production, encourages the very faults it is designed to cure.

Each city must make its own choice between clean, non-infected milk and dirty, disinfected milk. In many instances it may be as imperative for a city to accept a dirty, infected milk and place reliance on disinfection as for scores of our cities to take a polluted water and make it safe by purification. Where it comes to that, however, it may ultimately be found that the public is as unwilling to depend on private interests for its milk-supply as for its water-supply, and there may thus arise a demand for city-owned and operated milk-sterilization plants, to say the least.

To those cities which must place their reliance on disinfected milk, as well as to all believers in milk pasteurization, by choice or force of adverse circumstances, we commend the article on "The Holding Method of Milk Pasteurization," published elsewhere in this issue. The article is of engineering interest because it deals with the application of mechanical principles to the solution of an important sanitary problem. The article is also of sanitary importance, because it brings out clearly not only the underlying principles of milk disinfection, but also the unreliability of the ordinary "commercial" or "momentary" pasteurization which has been so generally practiced where milk dealers have had a free hand in the choice of the method employed.

We would call particular attention to the fact that while the averages for considerable periods (see tables in article) show less difference than might be expected between the bacterial contents of milk treated a few seconds and that treated 30 minutes, yet the diagram presenting monthly results shows wide fluctuations in the bacterial contents of the "momentarily" treated milk, while that treated 30 minutes gives not only a much lower, but a much more uniform bacterial content. The importance of this difference may be appreciated by anyone, and will be particularly apparent to those who have had occasion to study the bacterial results of water-filtration plants.

Is the U. S. Reclamation Service to Be Taken Away From the Civil Engineers Who Now Direct It and Placed Under Army Engineers?

In the Washington "Post" of May 4 there appeared a signed article stating that President Taft intends to detail an Army Engineer as head of the U. S. Reclamation Service in place of the present Director, Mr. F. H. Newell, M. Am. Soc. C. E. If this report is true it is of great importance to the engineering profession. We reprint a large portion of the "Post" article below. The sentences in it to which we wish to call special attention are as follows:

> Provided authority be granted by Congress, President Taft will detail an army engineer to take charge of the work which is now being carried on by Director F. H. Newell of the Reclamation Service.
>
> The plan has been under consideration for several weeks. It took definite form two days ago, when the House of Representatives passed a bill containing a provision whereby the President, in his discretion, might detail any engineer officer of the army to supervise or inspect any engineering project of the government. It is admitted that this piece of legislation is directly intended to open the way for a change in the administration of the Reclamation Service.

We wish this report might be dismissed as mere newspaper gossip, but the facts which have come to our knowledge indicate that its writer had a foundation for his statements. What is the bill to which he refers, as giving the President this authority? It is the bill providing for an increase in the Corps of Engineers (H. R. 7117), which has been so recently discussed in these columns.

As our readers will recall, when this bill was originally introduced, it was hoped by civil engineers that it might be so framed that it would remedy some part of the injustice under which the civilian engineers engaged in river and harbor work have for many years suffered. It was hoped that amendments might be adopted which would remove some of the underlying difficulties in the way of securing efficiency and initiative in this department of government work.

With this end in view, a committee of the American Society of Civil Engineers appeared before the House Committee on Military Affairs and urged the addition of an amendment to Section 4 of the bill. This proffered amendment was rejected by the House Committee, however, and the opportunity for a real reform in the United States Engineer service was thereby lost.

There was nothing in the bill, however, as reported by the Committee on Military Affairs to the House referring to anything but work already under the jurisdiction of the Corps of Engineers. On May 2 the bill was brought before the House of Representatives, and after a brief discussion was passed without amendment, so far as is shown by the "Congressional Record" of that date. But some time between the date of its report by the committee on March 23 and its passage by the House on May 2, an amendment of four lines was slipped into the bill—an amendment which is of vital interest to every engineer engaged in government service, and indeed to every engineer who values the prestige and reputation of the engineering profession. This is the amendment referred to in the Washington "Post" article above quoted. It reads as follows:

> Provided, That the President may, in his discretion, detail any army engineer to the supervision or inspection of any engineering work or works of construction carried on by the government pursuant to law.

The bill as passed by the House of Representatives, and as it is now before the Senate Committee on Military Affairs, therefore, makes it possible for an officer of the Corps of Engineers to be placed in charge of the work on government buildings under the Supervising Architect's Office, of the construction of drydocks for the Navy—in short, to any and every place where any work of engineering construction is carried on by the Federal Government; and let us not forget that engineering is a very, very broad term.

We understand that already those in charge of other government departments are protesting against the enactment of such a law, and there is a probability that the clause will be altered by the Senate Committee to exclude other departments of government work than the Reclamation Service. For we have information also that the clause above quoted was inserted in the bill *for the special purpose of placing an army engineer in charge of the Reclamation Service.*

Such amendment of the bill may remove the objections raised to it by the Supervising Architect's Office and the naval civil engineers. But it would make the bill even more pointed and definite as a direct blow to the civil engineering profession.

The civil engineering profession has looked upon the Reclamation Service with peculiar pride, as the first great example of a government bureau of engineering construction carried on by an organization of civilian engineers, selected with merit and efficiency as the sole criterion and free to carry on their work without political interference or graft. To have this bureau now turned over to the army engineers will be felt, we are sure, as a most serious humiliation by every member of the engineering profession who has pride in its work.

The question that will everywhere be asked will be, Why should such a change be made? If the civilian engineers had made a failure of the Reclamation Work; if dishonesty or inefficiency had been uncovered; if appointments in the Service had been made for political reasons; if political pressure had been effective in securing favoritism in the award or execution of contracts —if any of these things had been uncovered in the Service, there might then be some ground for saying that the organization of civilian engineers had made a failure of its work.

But it is our belief, based on many sources of information, that the engineering work of the Reclamation Service has been conspicuously successful. It has been a target for much criticism, we are well aware. We have given careful attention to many such criticisms, but in not one case have we been able to find that any serious fault on the part of the engineers of the service was established.

The Reclamation Work is admittedly one of extreme difficulty, not so much from the construction side as from the side of administration and organization. It was inevitable that complaints should arise; but when the foundation for these complaints is laid bare it will be found that the engineer has done the best he could under the circumstances in which he was placed. We protest most emphatically against the attempt to make the engineer the scapegoat for the errors and blunders which have been made by others.

It is fair to say that in the recent testimony before the House Committee on Ways and Means, which has in charge the bill to issue reclamation bonds to the amount of $30,000,000, many Congressmen from the West very frankly acknowledged that the chief difficulties in the efficient administration of the Reclamation Work had been due to the law itself and the way in which the law has been construed by the legal authorities, and not to any defect in the work of the engineers.

The question may well be asked, whether the officers of the Corps of Engineers themselves are responsible for this scheme to saddle the Reclamation Work upon them or whether they desire to assume this additional burden. To us it seems almost impossible that this can be the case. The very law in which this remarkable legislation is introduced is urged on Congress by the Chief of Engineers in the strongest terms, *because he has not now sufficient experienced officers to carry on the work for which his corps is already responsible.*

Why, then, should the Corps seek a huge addition to its responsibilities? It has nothing to gain by it; its members are already overworked, and, as we have often emphasized, underpaid, for the responsibilities they carry. Why should they seek to have this addition to their present field of labor, knowing, as they must know, that such a change would create a most deplorable bitterness between their corps and civilian engineers, that it would open anew the breach of long standing which has recently seemed in a fair way to be permanently healed? Knowing all these things, it seems hard to believe that the officers of the Corps of Engineers, or at least the best and ablest men among them, can be in any way responsible for this proposed piece of legislation.

And what is the argument for this revolutionary change? For an answer to this question we refer the reader to the Washington "Post" article which we have reprinted in full below. In printing it, however, we feel it proper to apologize to the army engineers among our readers. They know as well as we the weak points as well as the strong points of their organization and they will be, we are sure, disgusted rather than pleased with the absurd flattery which the writer awards to it. They may well petition to be delivered from fool friends.

But putting one side the extravagant laudation of the army engineers' abilities, let us come to the root of the matter as stated by the "Post" writer as follows:

> The starting of the plan means the precipitation of the long-impending battle between the supporters of the Reclamation Service under its present regime and those who are demanding a reorganization and general overhauling of that branch of the Interior Department.

In other words, if this proposed change is carried through and the Reclamation Service is turned over to the Army engineers,—if the large body of civil engineers engaged in the Reclamation Service have notice served upon them that they will hereafter have to carry the same burdens that the civilian engineers have long borne, the engineering profession can and should hold Secretary Ballinger responsible.

There was no "battle" and no "factional difference" in the Reclamation Service until he became its head. There would be none to-day, we feel confident, had the choice for the Interior Department portfolio fallen on some man of judicial mind, endowed with executive ability and with no prejudice against the Reclamation Service.

But there is a far larger issue at stake than the defence of the engineering profession and those of its members whose reputation has been unjustly assailed. The great issue is the Reclamation Work itself. Is that work to be carried on in the future with honesty, efficiency and economy? Is it to go on to larger success or is it to be permitted to receive blow after blow until the whole attempt to reclaim the arid lands by the Federal Government will be abandoned in disgust?

The cause which most appeals to us is the cause of the settler, the man who is seeking to create a home in the desert. Upon the success or failure of the Reclamation Service, his success or failure hangs. Upon its economy and honesty turns the cost of his homestead. And so we ask the question: Suppose the river and harbor works were not paid for from Uncle Sam's bountiful treasury; suppose the work of the River and Harbor engineers had to earn dividends as the work of other engineers has to. Suppose the mistakes that were made by the Army engineers (and by Congress in its River and Harbor legislation) all had to be paid for by the people who lived alongside the River and Harbor works. Suppose these mistakes were reflected every time in increased cost of the lands of these people. Is there one of our readers who knows the real facts who thinks that anybody would THEN seriously propose to place Army engineers in charge of the Reclamation Work?

We have heretofore protested in emphatic terms against the proposal to remove Mr. Newell from the Directorship of the Reclamation Service because of the principle at stake. The removal of an engineer of great ability, experience and efficiency from a position where he has most emphatically made good makes insecure the position of every engineer in the Service. But a far stronger protest is called for on behalf of the settlers on the Reclamation Works. Their interest in having efficient service is a vital one. We have given fair hearing to critics of the Reclamation Engineers as well as to friends, and we feel confident that the removal of Mr. Newell will be an injury to the settlers on Reclamation Works in the arid West which can hardly be overestimated.

Surely before the Administration perpetrates such a blunder it should be warned of its effect. If inefficiency or incompetence can be shown, let a change be made by all means; but it will take better evidence than any thus far presented to satisfy the public that any change is needed. Why not appoint a Board of Engineers, including if the Administration desires, army as well as civilian engineers, to investigate the Reclamation Engineering work and report upon its conduct. Without just cause, determined by such a Board, we believe the engineering profession will deeply resent the removal of Mr. Newell.

The Washington "Post" Article of May 4.

MAY REDUCE NEWELL.

TAFT FAVORS GIVING HIS WORK TO ARMY ENGINEERS.

AWAITS ACTION OF SENATE.

Trouble Between Secretary Ballinger and Director of the Reclamation Service Prompts President to Advocate Radical Steps to Complete Irrigation Projects. House Supports the Plan.

By ARTHUR C. JOHNSON.

A radical departure in the supervision of the erection of the government irrigation projects in the West is under contemplation by the administration. Provided authority be granted by Congress, President Taft will detail an army engineer to take charge of the work which is now being carried on by Director F. H. Newell of the reclamation service.

The plan has been under consideration for several weeks. It took definite form two days ago, when the House of Representatives passed a bill containing a provision whereby the President, in his discretion, might detail any engineer officer of the army to supervise or inspect any engineering project of the government. It is admitted that this piece of legislation is directly intended to open the way for a change in the administration of the reclamation service.

The eminent success of Lieut.-Col Goethals at Panama, in the construction of the big canal, has deeply impressed the President with the possibilities to be obtained by an extension of the duties of the army. Therefore, with this medium, he proposes to inject both speed and business-like precision into the immense amount of work still to be done toward the completion of the many dams, reservoirs, and canal systems which the government is furnishing the settlers in the West.

Battle is Expected.

This piece of information caused a flurry of gossip yesterday, for it was realized that the starting of the plan, through an act of Congress, means the precipitation of the long impending battle between the supporters of the reclamation service under its present regime and those who are demanding a reorganization and general overhauling of that branch of the Interior Department. President Taft is quietly arming himself with the means of hoisting the service clear of factional differences, and it is predicted that Congress will gladly accede to the plan.

The move came as a complete surprise to many persons who foresaw a change in the running of the reclamation bureau, but who had not contemplated a repetition of the method used by former President Roosevelt in straightening out the tangle experienced at Panama, through the employment of engineers from civil life.

It is pointed out that army engineers are already in control of scores of large engineering projects of the government in connection with the betterment of rivers and harbors, and that it is only a short step to the assumption of the big projects in the West.

No Politics in Corps.

It is believed that the hitches and annoyances which now are being experienced will be instantly removed, for there is no politics in the lexicon of the army officer, nor does he strive for other reward than the commendation which follows the proper discharge of his duty.

There has been both criticism and defense of the reclamation service since Secretary Ballinger assumed office. On the stand before the congressional investigating committee last Saturday the Secretary gave some idea of the conflict of authority which has been raging—a conflict which Mr. Ballinger says would have been settled had he not had his "hands up for months" through the general attacks on himself which he has been obliged to defend.

To the committee the Secretary portrayed a state of affairs which showed him and Director Newell to be

virtually deadlocked over a question of authority. The change proposed by Secretary Ballinger was the bringing of the reclamation office directly under the control of himself. Director Newell, under this plan, was given a greatly subordinate position. The reclamation director strenuously objected to the plan.

Many Millions Needed.

According to the statements of Secretary Ballinger, $50,000,000 has been spent on the 27 reclamation projects now under way, and it will take $70,000,000 more to bring them to completion. A bill providing for the issuance of $30,000,000 in bonds, to be repaid through the future sales of public lands, which has been passed by the Senate and is pending in the House, is expected to furnish the means for pushing most of the projects.

This measure is in bad straits in the House at present, and the cause of its delay is said to lie largely in the fact that the present director of the reclamation service is not willing to assert the great necessity for its passage, he having taken the ground that the additional funds would be welcome, but that the projects could be comfortably completed on the ordinary flow of moneys into the reclamation fund.

The measure through which the President hopes to receive authority to enable him to detail army engineers wherever there are government engineering projects is the bill to increase the efficiency of the engineer corps of the United States army. The bill is designed primarily to provide an increase of 60 officers for the engineer corps by the year 1916, making the number 248 instead of 188, as at present, and contains a proviso whereby the President may extend the usefulness of the corps.

Similar to Present Plan.

It is understood that the plan proposed is similar to the system which prevails at present in the erection of dams and locks on the navigable rivers, which are under the control of the War Department.

One engineer will be assigned to the supervision of the construction of all the reservoirs and canals which are at present under way, and will have authority to enter into contracts and see that they are executed.

Whether this officer will be detailed to the Interior Department, or will act under the control of the War Department, as the river and harbor engineers at present, is a question which naturally will arise, as soon as the departure shall have been authorized by Congress.

No doubt there will be some reluctance on the part of the army to detail its men to another department. The administration of the reclamation projects will have to remain, of necessity, in the hands of the Interior Department, however, and it is, therefore, likely that a plan of turning the entire construction of the projects over to the War Department will not prevail.

Although the engineer corps, as constituted at present, has not an extensive personnel, it is understood that the officers in command are willing to undertake the completion of the irrigation projects. In fact, they are said to consider the task comparatively small, compared to those they are called on to shoulder in connection with the navigability of the great streams and the harbors of the country.

Trained by Wide Experience.

Throughout the corps there exists an asset of wonderful training and a fund of experience, brought about by coping with the scores of great engineering problems constantly set forth by Uncle Sam. The quick and effective grasp of the small band of engineers sent to Panama is pointed out as an example of the ability of the wonderful engineering material which the President has at his command.

It was asserted recently by a prominent army engineer that any one of the 188 officers at present in the corps could instantly lay hold of a project even as stupendous as the Panama Canal and push it to a successful completion, such is the training that West Point gives to the army man.

The engineer corps personnel bill, containing the authority to extend the activities of the service, is now before the committee on military affairs of the Senate. It is said that its favorable report is virtually assured.

The Act "To Increase the Efficiency of the Engineer Corps of the United States Army."

(*As passed by the House of Representatives on May 2, introduced in the Senate on May 3 and referred to the Committee on Military Affairs.*)

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the commissioned force of the Corps of Engineers of the United States army shall consist of 1 chief of engineers, with the rank of brigadier-general, 15 colonels, 22 lieutenant-colonels, 57 majors, 60 captains, 56 first lieutenants, 43 second lieutenants, and 1 chaplain:

Provided, That the increase provided for in this Act shall be extended over a period of five years, as nearly as practicable, and that the original vacancies created by this Act shall be filled by the promotion in each fiscal year of not more than one lieutenant-colonel to be colonel, two majors to be lieutenant-colonels, three captains to be majors, four first lieutenants to be captains, and two second lieutenants to be first lieutenants.

Sec. 2. That vacancies in the grade of second lieutenant in the Corps of Engineers shall hereafter be filled, as far as may be consistent with the interests of the military service, by promotions from the corps of cadets at the United States Military Academy:

Provided, That vacancies remaining in any fiscal year after the assignment of cadets of the class graduating in that fiscal year may be filled from civil life as hereinafter provided:

And provided further, That the proportion of any graduating class assigned to the Corps of Engineers shall not be less than the proportion which the total number of officers authorized at date of graduation for that corps bears to the total number of officers authorized at same date for all branches of the army to which cadets are eligible for promotion upon graduation, except when such a proportionate number is more than the number of vacancies existing at date of graduation plus the number of retirements due to occur in the Corps of Engineers prior to the first day of the following January.

Sec. 3. That to become eligible for examination and appointment, a civilian candidate for the appointment as second lieutenant must be an unmarried citizen of the United States between the ages of 21 and 29, who holds a diploma showing graduation in an engineering course from an approved technical school, and is eligible for appointment as a junior engineer under the Engineer Bureau of the War Department. Selection of eligible civilians for appointment, including term of probation, shall be made as the result of such competitive examination into the mental, moral, and physical qualifications, and under such rules and regulations as shall be recommended by the Chief of Engineers and approved by the Secretary of War.

Sec. 4. That whenever it shall be necessary, in order to properly prosecute works of river and harbor improvement, the Chief of Engineers is authorized to detail for duty in charge of river and harbor districts, or as members of boards of engineers any assistant engineers in the employ of the Engineer Bureau of the War Department:

Provided, That the President may, in his discretion, detail any army engineer to the supervision or inspection of any engineering work or works of construction carried on by the Government pursuant to law.

Sec. 5. That the officers of the Corps of Engineers, when on duty under the Chief of Engineers connected solely with the work of river and harbor improvements, may, while so employed, be paid their pay and commutation of quarters from the appropriations for the work or works upon which they are employed.

Sec. 6. This Act shall take effect on the first day of July, 1910, and all laws and parts of laws inconsistent with the provisions of this Act be, and the same are hereby, repealed.

LETTERS TO THE EDITOR.

Has Anyone Experience in the Use of Bitumen for Fuel?

Sir: We have 3,000,000 cu. yds. of soft rock (salted marl and gypsum) to excavate in the desert west of Bagdad. Adjacent to the work is a lake 125 sq. miles in extent but the water is brackish and undrinkable. The only fuel available for condensing water for the laborers or for working dredges is bitumen. Can such work be done with bitumen? A satisfactory reply may lead to business.

Sir W. Willcocks.

Public Works Ministry, Constantinople, March 23, 1910.

Laying Out Railway Curves by 50-Ft. or 100-Ft. Chords.

Sir: In your issue of April 28 Mr. C. M. Kurtz refers to the "better and more modern practice of laying out curves . . . by 50-ft chords," and to the apparent difficulty, to him, of putting in track centers, on curves sharper than 5°, at other than even stations, which were originally laid out in the standard manner with 100-ft. chords.

Of course the 50-ft. or 25-ft. points can be put in, without forcing the alinement, as you state, by using a table of short chords, but if such a table is not at hand the error involved by putting in these points by measuring 25, 50 and 75 ft. from the even station is so small, in anything up to 15° curves, as to be negligible, and then the whole 100 ft. is measured to the next even station so that all the whole stations are correctly set. The error in distance in measuring 50 ft. for the half station on a 10° curve is only about 0.05 ft., and that makes such a slight difference in the deflection angle that any theoretical error is too small to affect the alinement of the track at all.

This method is quite generally used in putting in the 50-ft. points on location, which should always be done on curves over 5°; any awkwardness there might be in having to pull the tape ahead 100 ft. and then walk back 50 is more apparent than real.

The use of curves designated by the number of degrees subtended by 100-ft. chords is too well established to be thrown aside at this late day, and any fancied difficulties incident to its use which are "discovered" from time to time can generally be overcome by the exercise of a little ingenuity and are surely far less than the inconvenience of having two sets of radii.

F. Lavis, M. Am. Soc. C. E.

50 Church St., New York City, April 28, 1910.

Is There a Better Term Than Dosing Apparatus for Devices for Admitting Hypochlorites to Water Under Treatment by Those Agents?

Sir: The editorial in your issue of April 7, "The Growing Use of Hypochlorites of Sodium and Calcium as Water Disinfectants," in speaking of apparatus which is used to make solutions of the chemical substances and to feed them to the water to be purified, refers to it as "dosing apparatus." This appellation, which seems to the writer to be an unhappy one, is used in at least one of the other articles on this subject in the same issue of the News.

Names which may be termed technical are linked to various trains of thought in different individuals. To the writer at least, the thought of "dosing" is unpleasantly suggestive, and recalls early memories of his father standing on the manger administering medicine to a sick horse through a long-necked bottle. Perhaps in sewage purification "dosing" is an appropriate term; it does not seem, however, that semi-potable waters, which can so easily be purified, should have to suffer being "dosed" by even such valuable reagents as calcium or sodium hypochlorite in order to render many of them fit for general domestic uses.

Once "mangle" was a term widely used in describing a very efficient and relatively harmless piece of laundry machinery. Owing to the unpleasant thought formerly aroused in the minds of his customers, the up-to-date launderer now refers to his "flat-work ironer." Indeed it would be a short-sighted launderer who would dare to advertise his "mangling" facilities instead of telling of the excellent facilities of his "flat-work" department.

It can but serve to retard the full development of the scientific use of valuable purifying reagents to designate by ill-chosen names the apparatus or devices whereby they are fed to the water. Can you not suggest a name for solution-feeding apparatus which will be accurately and agreeably descriptive, and at the same time conveniently brief?

Very truly yours,

L. M. Booth.

136 Liberty St., New York City, April 29, 1910.

[We cannot see sufficient objection to this commonly-used, convenient and expressive term to warrant us in attempting to find a substitute.—Ed.]

Proposed Legislation Regulating the Discharge of Sewage into Streams in New York.

Sir: May I add a few words to the extracts from my letter, regarding the proposed law relating to sewage discharge, published in your issue of April 28.

The argument is that no drastic action relating to sewage discharge should be taken against a city situated on a *large body of flowing water* until a careful study has been made of the conditions existing along such a river and its tributaries. A large number of cities and towns are situated on the banks of the Mohawk, Hoosick and other rivers discharging into the Hudson above Troy. Most of these discharge sewage into these streams. They thus make the river, from a water-supply point of view, practically a sewer. Beside these, Albany and other cities on the Hudson, below Troy, do the same.

I have suggested an amendment to the proposed law, to the effect that before an order requiring such a city to separate and treat its sewage becomes effective, the city shall have the right to have the sewage conditions along the river and its tributaries studied by a board of engineers appointed by a court; the court to accept or reject its conclusions. If it be the policy to remove all sewage from a *large body of flowing water*, remove it; but the result will not insure pure water for the supply of a city as long as storm water from the streets of many cities is discharged into it. And especially is this so if storm-water overflows from combined sewer systems be permitted. If such be the policy, it should be applied all along the river and its tributaries. One city should not be singled out and ordered to do a thing impossible under the State Constitution. Even if it could do it, the result would be futile unless all cities on the stream were also made to treat their sewage.

Single or double filtration of surface waters where they have to be used, is, I believe, the most rational and practical way of insuring reasonably safe water-supplies.

It is of course understood that I am not referring to small streams which might become otherwise offensive, but only to a large body of flowing water in which screened sewage, forming only a small percentage of its volume, is discharged under water. Theoretically all sewage should be kept from all streams, but up to this time this has been found to be impracticable throughout the world.

Yours respectfully,

Palmer C. Ricketts.

Troy, N. Y., April 29, 1910.

A Simple System for Filing Blue-Prints.

Sir: Every engineering office, as well as all architects and contractors, and in fact every industrial and manufacturing concern have to take care of a lot of blue-prints. A filing system for blue-prints separate from tracings, drawings and everything else is in many offices an absolute necessity.

These blue-prints may originate from the tracings in the office; they may come in from one or more resident or division engineers; they may be sent over from the chief engineer's office, or from an architect's office; or, they may be collected from various outside firms. If prints all originate within the same company they may conform to one or more standard sizes. If collected from various sources, all sizes will have to be accommodated.

Where blue-prints accumulate in any quantity it becomes necessary to properly file them, not only by themselves, but so as to facilitate easy access for reference and use; but the system must be flexible enough for unlimited classification and expansion in any direction. Feeling the need of such a system the writer, about three years ago, originated a blue-print filing system which has given us entire satisfaction and has been put into use by a number of other offices with similar satisfactory results.

A blue-print, unlike a drawing or tracing, does not have to be kept smooth and uncreased for scaling or for printing. There is, therefore, no real objection to folding it. On the other hand, a blue-print is at one time or another almost certain to be folded, either for mailing or for carrying in the engineer's pocket when on outside work. Hence, as the print is ultimately to be folded, why not fold it with some system at the start, not only for its greatest usefulness when out of the file, but for systematic filing as well?

The first feature of this system is to fold all blue-prints "face out," not face in, as is the universal habit, which not only hides everything on it, but requires a complete unfolding to identify it, and often causes it to be torn by some impatient hand. On the other hand, if the print is folded face out, it can be identified without any unfolding and with no need of marks on the back, if it is originally folded in the proper manner. As practically all drawings, tracings and, consequently, blue-prints have their titles, numbers or other identifying features in the lower right-hand corner, the blue-prints are all folded "face out" as many times as is necessary to reduce their sizes to approximately the size of ordinary letter paper, 8½ × 11 ins. In so folding, care is taken to leave the title corner as one of the two final exposed faces. The title, number and characters, as well as the scale, date, names or initials of draftsman, checker, tracer and all other identifying information is always before the user without any unfolding.

As our blue-prints are now all folded to approximately letter size, with all necessary information on the surface, it is possible to utilize the modern office system of vertical letter filing, with all the convenient drawers, cabinets and transfer cases, besides the various guide cards and systems of indexing which have proven so useful and accessible in the up-to-date office letter file.

This saves the expense, trouble and delay of having a blue-print filing cabinet made to order, as vertical letter file equipment is standard the world over and can be obtained at any stationers. Besides, such a modern cabinet is far more compact in the small rooms of large office buildings, in the small fireproof vault, or the small temporary offices of contractors or engineers in the field.

The blueprints can be filed either according to serial number with a card-index of subjects, alphabetically arranged and cross indexed, or they may be filed according to subjects, with a card index for numbers; or, if it is warranted, a double card index could be used giving on one set of cards the titles and on the other the subjects. The system is thus capable of unlimited expansion and yet so clear that it is possible for any one to locate any desired print with only a vague description of the same, which after all is what is really desired of such a blue-print filing system.

Warren H. McBryde.

Pinole, Cal., March 16, 1910.

The Failure of the Pugh Fork Arch Bridge.

Sir: In the National Bridge Co.'s reply to my criticism of the Edinburg arch bridge in your issue of April 21, 1910, p. 468, is the statement, "If the arches had been built of stone with no reinforcement, as shown in Fig. 1, failure would have resulted." This means that the structure was not meant to act as a series of simple arches, even for dead load, but as a combination of arches and cantilevers, the forces being arbitrarily located by the designer.

In Fig. 1 of their reply (p. 469), they take the load from crown to pier on each arch applied at its center of gravity and combine this with the pier weight. To find the "resultant," the center of gravity of these three weights is found and their sum applied at this point. Thus the half-arches are taken as cantilevers. Suppose this were tried on a single span. The "resultant" would be a load equal to that carried by the arch, plus the abutment weight, applied away out, say one-third of the span away from the abutment. They have ignored the horizontal forces, the thrusts of the arches at the crown of each. These thrusts are applied at different elevations. If taken into account and given their proper values, the true resultant will be found to be located practically at the center of the pier.

The fact is ignored that the shorter arch with the higher rise and practically the same load per foot will of necessity have a thrust less in amount than the other, depending upon the squares of the spans and inversely as the rises. They continue to use the difference between the elevation of crown and higher springing as the rise of the short span. This is arbitrary and contrary to fact. If they had used this rise and for the span a distance double that to the high point as the effectual span they would be about right, and as this effectual span is about 9 ft. less than the 75 ft. their resulting thrust would be in close agreement with mine.

If a horizontal arch is raised at one end, the vertical ordinates of the curve remaining the same, the horizontal thrust remains exactly the same, and the vertical reactions on the two supports will equal the load between each respective support and the high or horizontal point of the arch. This is true even when the arch is brought to a position that makes it horizontal on one support. But it is seen that the vertical load on the high support is less and less as that support is made higher and higher. Thus the stability of the high pier is diminished by dropping the springing at the abutment, because the vertical load is less. This is just the case in the side arch of this bridge.

In their Fig. 2 (p. 469) they show the arch thrusts intersecting in the pier a few inches to the right of the center of the pier. Then they show the resultant of these two thrusts a large distance to the right of their intersection, a peculiar example of the resolution of forces.

In their Fig. 3 they deflect the line of thrust of the 75-ft. arch as far down at the crown and as far up at the springing as possible and the reverse with the 90-ft. arch, and still the intersection is almost within the pier. Also the resultant force on the pier cuts about at the edge of the middle third. What about provision for live load?

My calculations showing 5,000 lbs. of a fiber stress in the concrete are on the assumption that the other parts of the structure are doing only their proper duty. In many forms of construction, if one part is weak the other parts, by taking more than their share of the stress, will relieve the weak part and cause its stress to be less than that calculated for it in the normal distribution. Proper design, however, is accomplished by making each part capable of taking its share of the stress, so that one part will not be overstressed to relieve another.

The same reasoning applies to the case of the pier which I stated could take 10,000 lbs. of horizontal force, and which they point out sustained a force of 40,000 lbs. for a while. There must of course be a factor of safety, and a pier which could safely take a force of 10,000 lbs. would be expected to take several times that amount before failure, especially when aided by some bending strength in the arch and its spandrel. In spite of what they say about my error in stating that the pier is good for 10,000 lbs. of the horizontal component of the resultant force they show by their Fig. 3 that the pier will be just safe under a force of 67,000 lbs. in a direction that gives just about 10,000 lbs. as a horizontal component.

Yours truly,

Archy.

Pittsburg, Pa., April 26, 1910.

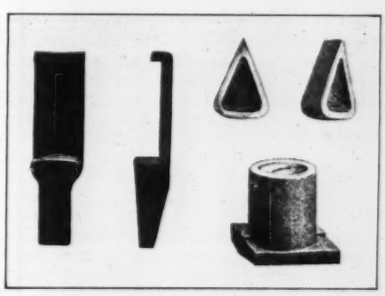
A REINFORCED-CONCRETE STAND-PIPE is to be built at Westerly, R. I., by the Aberthaw Construction Co., of Boston, Mass. The stand-pipe will be 40 ft. inside diameter and will have a height of about 100 ft.

Double-Disk, Parallel-Seat, Water, Gate Valve with Special Device to Prevent Sticking.

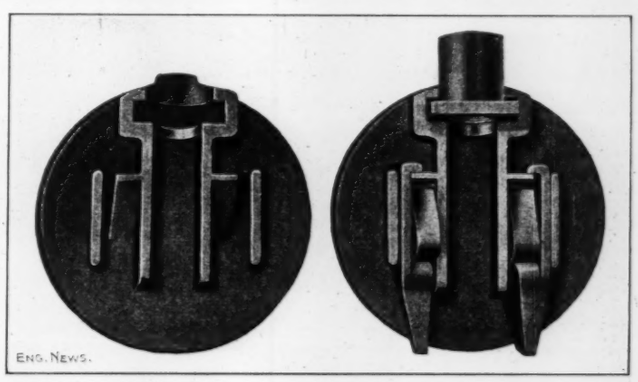
The gate valve illustrated herewith, which is of the double-disk, parallel-seat type, is so designed that when the valve is being opened one disk starts to rise slightly before the other. It is claimed that this makes it impossible for the valve to stick under any circumstances.

The illustration shows a valve with a stationary stem. The two disks are of cast-iron, exactly alike and interchangeable. On the back of each disk are cast raised portions which form pockets to hold the wedging mechanism and the square collar on the lower end of the stem-nut. The shape of the raised portions is clearly shown in the half-tone. The half-tone shows the backs of the two disks side by side, with the wedging mechanism and stem-nut in position against the disk at the right. When the two disks are placed together back to back in their operating position, the raised ribs form pockets for the stem-nut and wedges. The disks are held in position when lifted above their seats by the guiding walls of the valve body.

Valve Assembled.



Wedges, Wedge-Hooks and Stem-Nut.



Valve Disks with Stem-Nut. Wedges in Position in One Disk.

DOUBLE-DISK GATE VALVE WITH SPECIAL DEVICE TO PREVENT STICKING.

The wedges have equal angles on both wedging faces and are interchangeable. They are made of bronze and therefore will not rust to the disks. They are held in position and brought into operation by the cast-iron wedge-hooks. The shape of the hooks is evident from the accompanying illustration. They hook over the thick upper end of the wedge seats on the disks and each hook has a laterally projecting lobe which serves as a stirrup to support the base of the wedge. The lobes extend downward below the bottom edge of the disks so that they come into contact with the bottom of the valve body, when the valve is being closed, just before the disks reach their lowest position. As the disks descend further, the lobes of the hooks push up on the bases of the wedges and the wedging action moves the disks squarely against their seats.

The stem-nut is of bronze. Its square collar engages the slot at the top edges on the backs of the valve disks so that the disks are carried along with the nut as it is traversed by the stem.

The lower edge of this collar is made even on the two sides so that both disks when closing are brought down evenly together. The upper edge of the collar, on the other hand, is made with a step higher on the side engaging one disk than on the other. When the nut rises to open the valve, the high side reaches the top of its disk slot ahead of the low side and thus one disk is raised the first fraction of an inch before the other disk starts. This, it is claimed, improves upon the action of other double-disk valves and eliminates all possibility of sticking.

Valves of this type, made by the Kennedy Valve Manufacturing Co., Elmira, N. Y., under the trade name of "Newtype," are to be used to supply this year's requirements of the Water Department of the city of Cleveland, Ohio.

Walter Craig Kerr.

The death of Walter C. Kerr, President of Westinghouse, Church, Kerr & Co., occurred May 8 at Rochester, Minn. Mr. Kerr went to Rochester about two months ago for treatment from Drs. Charles and William Mayo. An operation for cancer was found to be imperative and, although the operation was apparently successful, complications developed which caused his death. Up to the time of his going to Rochester, Mr. Kerr was actively engaged in the business of his company.

He was born at St. Peter, Minn., Nov. 8, 1858, the son of a Presbyterian clergyman, and received his early education in the public schools of his birthplace. He decided upon mechanical engineering as his profession and took up the course in that subject at Cornell University, graduating in the class of 1879. After his graduation, he remained at Sibley College as an instructor and later became an assistant professor. The organization of Westinghouse, Church, Kerr & Co. was effected in 1884, and from the first Mr. Kerr was one of the officers of that firm. Much of the credit for the growth and success of the company of which he was so long President is due to his forceful character and genius for organization.

Mr. Kerr was at one time Vice-President of the Westinghouse Machine Co., and at the time of his death was a director of the Electric Properties Co. He was a member of the American Society of Mechanical Engineers, the Canadian Society of Civil Engineers and the Franklin Institute and an Associate of the American Institute of Electrical Engineers. He held membership, too, in the Engineers' Club of New York City, the New York Railroad Club and several others. Since 1890 he had been a trustee of Cornell University.

Mr. Kerr's residence for the past 14 years was at Dongan Hills, Staten Island. He had many interests apart from his business activities and revealed in his conversation a remarkable fund of general information and an intimate knowledge of a number of special subjects. Among his many avocational pursuits were yachting, the collection of precious stones, biological studies and the study of plans for the improvement of educational methods.

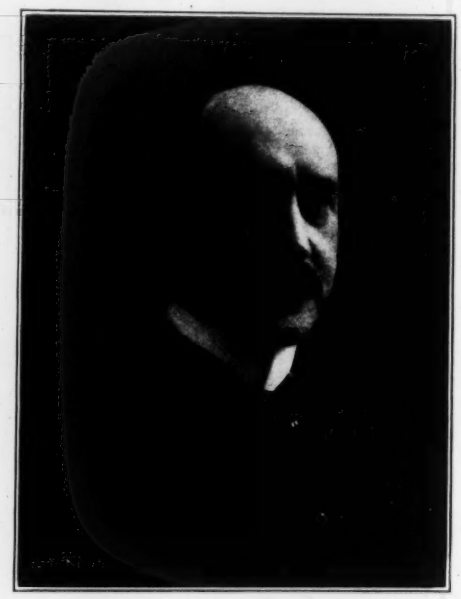
He was married in 1884 to Miss Lucy Lyon, of Ithaca, N. Y., who was with him at the time of his death. His son and three daughters also survive. The funeral service will be conducted from the residence at Dongan Hills.

THE BUSH TYPE OF TRAINSHED invented by Lincoln Bush, M. Am. Soc. C. E., and in use at the Hoboken terminal of the Delaware, Lackawanna & Western R. R., is the subject of a patent recently issued to Mr. A. L. Moorshead, Assoc. M. Am. Soc. C. E., of Jersey City, N. J., Resident Engineer of the Erie R. R. Mr. Moorshead has designed a trainshed which is claimed to be an improvement over that in use at the Lackawanna. It resembles the Bush shed in having a succession of low roofs, each covering a single platform and the tracks adjacent on either side, and also in having longitudinal slots over the center of each track, formed in reinforced concrete, through which smoke and steam can escape. It differs, however, in having the columns which support the roof placed between the tracks instead of in the center of the platforms. The invention is covered by a patent issued March 29, 1910, No. 953,633.

Stipulations Between the United States and the Passaic Valley Sewerage Commission Regarding the Discharge of Sewage into New York Bay.

As many of our readers know, the Passaic Valley Sewerage Commission, potentially representing Paterson, Passaic, Montclair, some of the Oranges, Newark and other communities in the lower drainage area of the Passaic River, adopted plans some years ago for a trunk sewer and for works of final disposal. The plans included a somewhat indefinite scheme for screening and sedimentation works on the meadows adjacent to Newark Bay, from which works the effluent was to be pumped beneath Newark Bay and the Bayonne Peninsula to a system of deep submerged multiple outlets not far from the Statue of Liberty, in New York Harbor. Before construction was begun, the State of New York brought suit to prevent the discharge of sewage into the bay, under the proposed plan, and the United States subsequently joined in the suit. Before the suit had proceeded far the parties in interest joined in an effort at a compromise.*

The compromise was effected after a long series of negotiations. It took the form of a "stipulation and contract" between the Passaic Valley Sewerage Commission and the United States, under which the United States agreed to withdraw from its intervention in the suit brought by the State of New York, on condition that the Commission agreed to build sewage treatment works of a certain kind and capacity, and to operate the works so as to produce certain results, all to the satisfaction of representatives of the United States. The New Jersey legislature passed an act, a few weeks ago, enabling the Commission to enter into the agreement. It is understood that the agreement has been signed by both parties. It is also understood that the State of New York will drop its suit against the Commission and the State of New Jersey.



(From Photo by Davis & Eickemeyer.)

*In connection with this effort Col. W. M. Black, Chief Engineer Officer, Department of the East (Army Building, New York City) made two reports on the proposed discharge of the Passaic district sewage into New York Harbor. These reports, which were abstracted at length in our issue of Oct. 21, 1909, reviewed the whole question of harbor pollution, the relation of both the Passaic and Bronx valley sewer outlets thereto, the then status of sewage treatment (as understood by Col. Black), and concluded with recommendations as to the conditions which should be met by the Passaic Valley Sewerage Commission as to the character of the sewage effluent discharged into the harbor. It may be added that in our issue of Dec. 17, 1908, we published a report of a hearing before the New York Harbor Line Board on the application of the Commission for a permit from the Secretary of War to construct works beneath Newark and New York bays for the disposal of the sewage in question. The substance of the report of the Harbor Line Board was given in our issue of Oct. 21, 1909, already mentioned.

Through the courtesy of Mr. John Gibson, Clerk of the Passaic Valley Sewerage Commission, Newark, N. J., we are able to present a copy of the "stipulation and contract," as follows:

Whereas, the Solicitor General of the United States acting for the Attorney General of the United States and this board and the attorneys for this board and Robert H. McCarter, Esq., representing the Attorney General of this State, with the engineers of this board have had under advisement the making of a stipulation and contract with the United States, upon the making of which the United States will withdraw from the suit now pending in the U. S. Supreme Court between the People of the State of New York, the United States Intervenor, Complainants, and the State of New Jersey and the Passaic Valley Sewerage Commissioners, Defendants; and

Whereas, in order to effect a settlement of the said litigation with the United States, it is important that such stipulation shall receive the approval of this board, and that this board be authorized by act of the Legislature to sign such stipulation;

Therefore be it Resolved, That this board approve of the following stipulation and agreement, and when authorized by legislative act, will enter into the said stipulation and agreement with the United States:

First: The Passaic Valley Sewerage Commissioners agree with the United States that the sewer system to which the suit relates shall be constructed, maintained and operated if at all, in accordance with the following requirements:

(a) Upon the line of the trunk sewer which it is proposed shall be constructed, and at a point at or near the pumping station to be located on the Newark meadows near the Newark Bay, it is stipulated and agreed that the sewage, waste and other matter passing through the said trunk sewer shall first pass through coarse screens to remove therefrom all large floating matter, and after passing through such coarse screens shall pass through a grit basin or basins where the heavy matter therein shall be taken out as far as practicable, from which basin or basins the sewage and other matter shall pass through self-cleansing mechanical screens having clear openings of not over 0.4-in.

(b) As the sewage comes from the fine screens, it shall also pass through sedimentation basins. The sewage after passing through said grit basin and said self-cleansing mechanical screens shall enter the sedimentation basins or settling tanks, consisting of a number of units, each approximately 225 ft. long and 15 ft. deep. Each tank will have a normal capacity of not less than 1,250,000 gals., making an aggregate tank capacity sufficient to meet the requirements as stated herein. The tank capacity shall always be such as to provide a detention period of not less than one hour at the maximum rate of flow of the sewage and a detention period of the daily average flow of such sewage for not less than 1½ hours. The mean lineal velocities through said tanks shall not be over 0.5-in. per sec. for average flow, and 0.75-in. per sec. for the maximum flow. In addition to and in connection with these basins scum boards shall be provided to retain the floating matter, and proper and adequate devices shall be used to remove the retained scum and deposits from the settling basins.

(c) The sewage and waste thus screened and settled is then to flow into a pump well, whence it is to be pumped under pressure through a tunnel to a point in the New York Bay near Robbins Reef Light, at which point it is agreed that the matter passing through the said tunnel shall be dispersed into the waters of the New York Bay through a series of outlets discharging 40 ft. or more beneath the surface of the water at mean low tide. From the end of the tunnel connections shall be made with four or more discharge pipes extending across the current, spaced about 100 ft. apart, laid in trenches on the bottom of the Bay, and of a size decreasing in diameter from about 6 ft. to 2 ft. On the top of these discharge pipes will be a series of not less than 150 tees of a diameter not exceeding 1 ft. spaced approximately 10 ft. apart. On each of these vertical tees shall be placed outlets arranged to discharge horizontally across the tidal current, and the extent of the dispersion area used for this system of outlet pipes shall cover at least 3.5 acres of the bottom of the bay.

Second: The Passaic Valley Sewerage Commissioners further agree with the United States that in the operation of said sewer system at all times the following results shall be secured, either through compliance with the requirements of the immediately preceding paragraphs, or through requisite lawful additional arrangements, viz.:

(1) There will be absence in the New York Bay of visible suspended particles coming from the Passaic Valley sewage.

(2) There will be absence of deposits objectionable to the Secretary of War of the United States in the New York Bay coming from the Passaic Valley sewage.

(3) There will be absence in the New York Bay and its vicinity of odors due to the putrefaction of organic matters contained in the Passaic Valley sewage thus discharged.

(4) There will be a practical absence on the surface of New York Bay of any grease or color due to the discharge of the Passaic Valley sewage at the dispersion area or elsewhere.

(5) There will be no injury to the public health which will be occasioned by the discharge from the said sewer into the Bay of New York in the manner proposed and no public or private nuisance will be created thereby.

(6) The absence of injurious effect from said sewage discharge, upon the property of the United States situated in the Harbor of New York.

(7) The absence of reduction in the dissolved oxygen contents of the waters of New York Bay, resulting from the discharge of Passaic Valley sewage, to such an extent as to interfere with major fish life.

Third: The said Passaic Valley Sewerage Commissioners further agree with the United States that so long as said sewer system, or any part thereof, is operated the United States shall have, through such representatives as may be designated by the Secretary of War at any time for such purpose, full opportunity to inspect the condition and working of the sewer system, with a view to determining whether this contract is being in all respects performed, and that the said Passaic Valley Sewerage Commissioners will render such expert or other assistance as the United States may desire in the course and in aid of such inspection and determination.

Fourth: The United States agrees with the Passaic Valley Sewerage Commissioners that forthwith upon the filing of this agreement, properly executed, in the office of the Clerk of the Supreme Court as a stipulation of the parties in the suit, it will discontinue its intervention in the above entitled suit and will cause its petition of intervention to be dismissed without prejudice, and will not again intervene in said suit.

Fifth: The United States and the Passaic Valley Sewerage Commissioners mutually agree that this contract shall not become effective in any part, except the next succeeding divisions, unless or until all such permits as would be requisite under the statutes of the United States for the construction, maintenance or operation of said sewer system without this contract are actually obtained from the United States, or unless or until such permits are made conditional upon compliance at all times with all the terms and requirements of the divisions of this contract numbered First and Second, whether, or not such permits contain other terms or conditions.

Sixth: The Passaic Valley Sewerage Commissioners hereby consent that full compliance at all times with the terms and requirements of the First and Second divisions of this contract be made express conditions of any permits issued by or on the part of the United States for construction, maintenance or operation of said sewer system, and agree with the United States that this contract shall establish such consent before all officers of the United States.

Seventh: It is agreed between the United States and the Passaic Valley Sewerage Commissioners that this contract shall bind and also shall inure to the benefit of the successors of the latter.

So far as the lawsuit in question is concerned it appears that the Commission may now proceed with the construction of the proposed trunk sewer and disposal works. It may be added that under the New Jersey statutes it is left to the various municipalities in the Passaic Valley Sewerage District to decide whether or not they will make use of the trunk sewer and disposal works. Most of the communities, through their city councils, have decided to do so.

Second National Conference on City Planning and the Problems of Congestion.

That a considerable number of thoughtful men have at last awakened to the need of giving careful consideration to city planning with an eye to facility of the movement of foot and vehicular passengers and of goods, and with due regard to sanitation and the general fitness of the city plan to the needs of city dwellers, was shown by the conference on city planning and allied subjects, held at Rochester, N. Y., May 2 to 4. It is true that the proceedings showed the subject to be in a rather nebulous state, so far as those present were concerned, but this was partly due to the attempt to consider city planning and congestion of population in the same conference. Quite wisely, it seems, "congestion" will be dropped from the title of the conferences in the future and it may be expected that hereafter that subject will take a relatively incidental part in the proceedings, instead of being made coordinate with city planning.

It would be difficult to characterize the membership of the conference. Nearly all present were unquestionably devoting themselves to the betterment of cities and city living. Aside from those primarily interested in improvement of the social and living conditions of city dwellers, the membership of the conference was divided between landscape architects and civil engineers, with the former perhaps predominant in numbers but the latter equally active in the deliberations on the floor.

As chairman of the executive committee Mr. F. L. Ford, M. Am. Soc. C. E., City Engineer of Hartford, Conn., played a leading part in the conference. He was seconded by Mr. Frederick Law Olmsted, Landscape Architect, Cambridge, Mass. A reading of an outline of the proceedings, which follows, will show that a number of prominent engineers took an active part in the conference. It will also show that city planning, as conceived by those in attendance, puts questions of esthetics second instead of first. For the most part, as Mr. Olmsted well expressed it, art is realized in city planning through the functional fitness of every element of the city plan and the proper correlation of each element to the whole rather than through the mere addition of ornamentation. This, of course, does not mean that direct and conscious art efforts are out of place, but that they should come naturally rather than by artifice.

After the formalities incident to opening a convention had been gone through with, the serious work of the conference was begun by a general introductory address delivered by Mr. Frederick Law Olmsted, of Cambridge, Mass. The problem of city planning consists largely, Mr. Olmsted said, in controlling and harmonizing many complex factors of city life. Among these problems are: (1) Circulation, which includes streets, railways and waterways; (2) spaces devoted to all other public purposes, including parks; (3) the control of private lands.

It is strange that until recently, both at home and abroad, only proprietary interests have been considered in city planning, leaving the interests and convenience of the public quite secondary. The gridiron plan and fixed street widths regardless of the character and uses of the streets have been quite generally adhered to. There is need for considering the city plan as a whole, from the greatest railway system to the smallest alley. This will not be done until all the parties in interest get together and agree on sites for buildings and institutions, each in relation to the whole.

As to private lands, the shape and size of lots is governed by the street plan of the city. Methods and rates of taxation also have a great effect on the control of private lands. Beyond these things, the chief public control of private lands comes through the police power. What this power is depends largely on public opinion, which is constantly shifting. Building codes first relate, as a rule, to structural features; later, to sanitary. Plumbing regulations will probably be simplified, while those relating to light and air are likely to become more rigid. An examination of the building laws of 35 cities shows great divergencies as to air and light requirements, and entire absence of rules on the subject in some cities. It is probable that building regulations by zones or districts will become more common.

In conclusion, Mr. Olmsted remarked that he had said nothing as yet about beauty. This is best considered in city planning, as in the old sailing ship, as an outcome of the developments of all lines in accordance with fitness for the purpose to be served.

The Causes of Congestion of Population.

A whole day was devoted to city congestion, half to the causes and half to the remedies. All through the day there was clash of opinion as to what constitutes congestion and the extent to which it exists in American cities.

The discussion of causes of congestion was opened by Mr. Benj. C. Marsh, Secretary of the Committee on Congestion of Population in New York City. There was no doubt in his mind as to either the fact or the cause of congestion. The causes, in his opinion, are first of all the high cost of land, and next low wages. The massing together of factory and office buildings results in bringing together masses of people who must be housed near by, on account of long hours of labor and lack of transportation facilities. Then, too, the prevailing system of municipal taxation causes congestion, because land and accumulated wealth escape taxes and the burden falls on the rent payer. Faulty regulations as to the percentage of lot areas that may be built upon and as to the height of buildings, combined with inadequate enforcement of such regulations as exist, are further causes of congestion.

Land values, Mr. Marsh stated, are congestion capitalized. Why, he asked, should the manufacturer and the consumer be called on to pay wages that include an eternal profit to land speculators?

Congestion as it exists in Chicago, Boston and Philadelphia, was set forth by different speakers. Mr. Geo. E. Hooker, Secretary of City Club of Chicago, said that congestion in Chicago was chiefly associated with occupation and transportation. There is an enormous concentration of industry, more or less classified, in the mile or two of "downtown" Chicago. Proprietors of individual buildings have provided quick, free vertical transportation, but there has been a lack of unified provision for horizontal movement of population. The recent partnership of the city and street railway companies tends to perpetuate the lack of transit facilities. The ultimate cause of congestion in Chicago is lack of a city plan.

Mr. Edward T. Hartman, of Boston, defined overcrowding as a provision of less than 500 cu. ft. of air space per occupant of a house, and congestion as so large a number of rooms on a given area as to make proper air and light impossible. City transportation lines are overcrowded and poorly ventilated. Factories and transportation lines are not properly correlated.

Relief for Congestion of Population.

Mr. Grosvenor Atterbury, of New York City, explained the difference between concentration of population, which is inevitable, and congestion, which should be avoided. He thought land might properly be utilized up to its "safe load limit," which latter should be controlled by good city planning, by scientific housing and by proper legal control of house occupancy. Decentralization of population may be aided by regulation, by education, by adequate transportation facilities, by proper factory legislation and by providing means for intensive "garden farming."

Mr. Lawrence Veiller, Director National Housing Association, New York City, seemed disposed to take exception to some part of the remarks of nearly every previous speaker, but he did it with little cause for offense. In the first place, he doubted whether anyone in the room knew what congestion is, its cause or its remedy. It is, however, a complex of industrial, social, economic and sanitary conditions. No city in the United States to-day, outside New York and Boston, is congested.

Concentration is inevitable in cities. They cannot spread out into the suburbs. It is simply a question of how high up population can go with safety. It is perfectly possible to house 3,000 persons per acre without evil effect. It is not narrow width but rather extreme depth of lots that is dangerous. Turn the 25 × 100-ft. lot around so as to give 100 ft. frontage and 25 ft. depth and you have houses only two rooms deep, with light and air for each set of rooms. Make the streets as wide as the height of such houses and air and light will be ample.

There being expressed from the floor a desire for something more definite in the way of what constitutes congestion, Mr. Veiller said he could do no better than to define congestion as an undue concentration of population on land, but Mr. Atterbury went a little further and offered as a tentative answer, "any excess of population above that consistent with sanitary living."

Mr. Milton D. Morrill, an architect of Washington, D. C., presented a paper on "Inexpensive Homes of Reinforced Concrete." The paper dealt wholly with personal experience and plans. Mr. Morrill described what he termed detached

"box-like" houses, made by the aid of standard forms consisting of steel plates clamped together. Sinks, mantels, laundry tubs, garbage closets, etc., are molded in concrete. Walls 6 ins. thick are used, and in these concrete has been placed at a cost of $4.65 per cu. yd. One or more of these houses have been built and others are more less definitely under way. The cost is estimated at $200 to $300 per room, but no definite statement as to size of rooms was made.

"Municipal Taxation, Town Planning and Housing" was the title of a paper by Mr. Frederic C. Howe, of Cleveland, O. The gist of the paper was that the prohibitive price of land for building purposes is the real obstacle to proper city building, housing, parking and all that makes for the healthful and beautiful city; and that the remedy is to tax land values instead of buildings and improvements. In other words, tax the unearned increment and money enough for all municipal expenses will be forthcoming while at the same time land values will fall and land owners and speculators will speedily compete with each other in erecting buildings to meet the needs of all. German cities are rapidly adopting this plan with marked success.

Papers on "The Proper Distribution of Factories," by Edward E. Pratt, New York School of Philanthropy; on "Villages for Workingmen," by Warren H. Manning, Boston; and on "The Copartnership Principle," of town building, by Robert A. Pope, New York City, completed the very full afternoon program.

The Circulation of Passengers and Freight in Relation to the City Plan.

Having given the "congestion of population" element of the conference two sessions, the final day of the conference was devoted to the more specific general topic of city planning.

STREET WIDTHS AND THEIR SUBDIVISIONS.—Mr. John Nolen, of Cambridge, Mass., urged the importance of giving more attention to the street plans of cities, particularly since when a street is once established it is very difficult to change it. More variety in street widths is needed and more discretion in apportioning the widths between roadways, walks and grass or other planting strips. In the new plan for Chicago [wholly unofficial as yet.—Ed.] main streets range from 120 to 180 ft. in width and provision is made for diagonals. German cities show many examples of wide streets, and no hard and fast rules as to either widths or subdivisions of widths; nor is symmetry always sought.

Washington St., Boston, has a roadway only 30 ft. from curb to curb, on which there are two street railway tracks and as much other traffic as can find a place for itself. This is a notable example of lack of city planning. In contrast, some years ago the relatively small town of Brookline, Mass., widened Beacon St. from 50 to 150 ft., for a distance of two miles, at a cost of $600,000, of which the town paid $400,000. Within six years property values within a short distance of the widened street increased by a total of $4,500,000. The example set by Brookline was subsequently followed, as regards the same street, by Boston at one end and other towns at the other end.

In discussion, Mr. F. C. Howe, of Cleveland, stated that German cities lessen the burden of street improvements by distributing the assessments over a long period. He also said that street-service pipes are placed beneath the sidewalks, to the manifest advantage of the pavements. Mr. M. N. Baker, of New York City, called attention to the difficulty of securing good pavements for streets and maintaining the pavements after they are laid. Grass is much cheaper, and may well be substituted where street widths are beyond traffic needs.

RAILROADS.—Mr. Geo. R. Wadsworth, M. Am. Soc. C. E., Consulting Engineer Metropolitan Improvement Commission, Boston, discussed railroads as affecting the framework of the city plan, laying particular stress on suburban traffic and local freight delivery. The workingman should preferably be taken to and from his work without the necessity of transferring from a steam to an electric line.

Speaking broadly of the whole question, the present unsatisfactory condition of railway terminal facilities is due to the fact that they are the outcome of individual, rival development instead of a centralized and unified development in the interests of the public as a whole. With a few notable exceptions, all the transportation and terminal experts are in the service of the railways. There should be an official public body with full jurisdiction over these matters. Preferably, each railway should be represented by its own expert.

A member of the conference remarked that heretofore the demand for public ownership of railways has come from the rural districts, through a desire to control rates, but hereafter a similar demand is likely to arise from cities, in order that public interests may be given due consideration.

RAPID TRANSIT AND THE HOUSING PROBLEM.—Mr. Henry C. Wright, of New York City, presented an interesting estimate of the cost of a rapid transit subway in New York City, designed to take workingmen from the down-town districts to less crowded parts of the city—assuming for his purpose that they would be willing to go. It appeared from his figures that such a line would not pay, unless capital charges could be reduced by assessing a part of the cost on land occupied by the traveling public served. The short haul fares would help out some, but as trunk lines below 59th St. increase these fares will decrease, relatively.

The ideal plan would be to locate factories in the outlying districts and house the workers close by, but aside from the difficulties of getting the workers to live outside the crowded parts of the city there are serious questions of freight and express charges for the manufacturer and questions of business advantage through being located in the main part of the city.

Mr. Wright suggested a reduction of service costs by an extension of the existing combination of suburban traffic with the through passenger and freight service of the steam railways, and the adoption of some means of putting the commuter on the steam roads within walking distance of his shop or office. In discussing the paper some approved and others questioned this plan. It was suggested that the root of the difficulty is the immense terminals required by the steam railways, and that electrification and loop lines would be a more likely solution of the problem.

PLANNING UNDEVELOPED CITY AREAS.—A well put and well received paper on this subject was presented by Mr. Nelson P. Lewis, M. Am. Soc. C. E., Chief Engineer of the Board of Estimate and Apportionment, New York City. The paper is reprinted elsewhere in this issue. Some prefatory remarks, not included in the formal paper, may be given here. Mr. Lewis stated that the city he represented presents a horrible example of how not to make a city plan. He added that there is no possibility of a city plan for New York under existing conditions, for each borough president of the five boroughs is supreme in his bailiwick and is in rivalry with the other borough presidents, and really carrying out old village ideas. This prevents unified action.

Mr. John Nolen felt that it is exasperating and humiliating that a city official with such good ideas on planning as had been expressed in the paper by Mr. Lewis should be impotent to carry them out. Another speaker suggested county control of street extensions into outlying districts certain to become parts of the city. Mr. Ihlder, of Grand Rapids, said that under the new home-rule constitution of Michigan cities in that state are given control of street extensions for a distance of two miles outside their limits.

Mr. Geo. S. Webster, M. Am. Soc. C. E., Chief of the Bureau of Surveys of Philadelphia, told how that city had controlled street extensions for the past 55 years. The city and county are coextensive, and are divided into 14 districts, each with a surveyor. These men, with the Chief of the Bureau of Surveys, constitute a board which controls the extensions of streets. The initiative rests with Councils, but the Board of Surveys lays out all main arteries. Intermediate streets are largely at the will of property-owners, but the Board has some control over these also.

Some Problems of Legal and Administrative Procedure Affecting the City Plan.

EXCESS CONDEMNATION PROCEEDINGS AND PUBLIC USE.—The plan common to many European cities of taking by condemnation more land than is necessary for public purposes and subsequently selling the excess at a profit that helps to pay for the land finally retained was discussed in relation to American conditions by Mr. Andrew W. Crawford, Assistant City Solicitor of Philadelphia. Mr. Crawford was of the opinion that any such excess taking for the mere purpose of saving the city money would be against the Constitution of the United States, since such taking would not be for public use and could not be by "due process of law." But if the excess taking were for such a purpose as preserving or protecting parks or parkways by means of restrictions placed on the excess property when resold, then it might perhaps be upheld by the courts. There is no doubt but what a city could take an easement, instead of purchasing in fee simple, in order to prevent the erection of billboards, an undue height of buildings, or the emission of dense smoke to the detriment of an adjacent park or parkway.

THE PROBLEM OF EXTENDING THE CITY PLAN.—This subject, with particular reference to Baltimore, was presented by Major Joseph W. Shirley, Chief Engineer Baltimore Topographical Survey, Baltimore, Md. The author said that on making inquiry he was greatly surprised to find that scarcely any American cities have control over the extension of their street systems. Washington, Philadelphia and one or two other cities have such control. Most cities replied that they had no street plan whatever.

In 1888 Baltimore added 17 sq. mi. to its area and appointed a Topographical Commission to map this as well as the original area of the city. The map has proved invaluable. After completing the map attention was paid to street extensions in the annexed area. The plans of various engineers were considered, and one of these was adopted. It would have been better had a landscape architect been called in to pass on the rival plans, but that was not done. Still, any plan at all is better than no plan.

Although it is against the law to erect a building in the bed of a street laid out on the extension plan, or to open a street that does not conform with the plan, yet both have been done and the courts refuse to prevent it. Possibly the city authorities may get the better of persons doing this by refusing water extensions, etc. In Philadelphia, the city controls the situation, because it can and does refuse to give lines and grades to builders unless the latter conform to the street layout. An act of the Massachusetts legislature [applicable to Boston, only?] prohibits the laying of water mains in streets not conforming with the street system.

Mr. N. P. Lewis said, in discussing the paper just read, that the New York courts have held that a man may use his property as he chooses; so any property-owner may build on land not actually dedicated to the public, regardless of city street extension plans. As a consequence, "house planting" has become a pleasant and profitable occupation. A man will erect a building partly within the area of a street extension site. When the city proceeds to open the street the building must be condemned. After the city has paid the owner heavy damages for the building and acquired ownership of it, the city advertises it for sale. The original owner thereupon buys it for $5 or $10, moves it back onto the lot, or else shifts to another unopened but laid-out street to repeat the blackmailing process.

Mr. Crawford said that in Philadelphia if any one builds a house in the bed of a laid-out street he can get no damages for the building when the street is opened. A speaker from Chicago said

that no one could register lot and street layouts unless approved by the city map department.

THE COMMISSION ON THE CITY PLAN OF HARTFORD, CONN.—Mr. F. L. Ford, a member of the commission just named, described its organization and powers. The city is governed by a mayor and a two-chambered council, and there are in addition numerous bi-partisan administrative boards. A number of these have to do with streets and other parts of the city plan. Recently a commission on the city plan was created by legislative enactment. It is composed of the mayor, the presidents of the street and park commissions, the superintendent of parks (added in 1909), the city engineer, two citizens appointed by the mayor, and one member each from the two branches of the city council, appointed by the respective branches. All questions regarding the location of streets and parks go to this commission, and other matters may be referred to it by the city council. The commission may prepare city plans as it sees fit, and may employ experts for the purpose. The city of Hartford, through the commission or otherwise, is given powers of condemnation of more land than is needed for public improvements and of selling the excess ("excess condemnation"). The engineering department is now preparing plans for street extensions to cover all the outlying districts of the city. An ordinance now in force requires that all property subdivisions must be approved by the commission before they can become legally effective. Carrere & Hastings, New York City, have been engaged as consulting landscape architects to the commission.

THE ENGLISH TOWN PLANNING ACT OF 1909.—An outline of the provisions of this act was given by Mr. Flavel Shurtleff, of Boston. [Some features of the act were described, with editorial comment, in Eng. News for March 17, 1910.] The bill empowers the Local Government Board to authorize local authorities to prepare town-planning schemes for areas yet to be built upon or to adopt plans proposed by land owners, but in either case the plans must be approved by the central board named. Proper "sanitary conditions, amenity and convenience" by means of land and street development with a mind to the needs of the future are the grand objects of the bill. If local bodies neglect to carry out the objects of the bill the Local Government Board may call on them to act.

OTHER PAPERS.—A number of other papers on the lengthy program were read by title, only.

Organization and Future Plans.

The executive committee, of which Mr. F. L. Ford, Am. Soc. C. E., City Engineer of Hartford, is chairman, reported a plan for future organization and scope of work through Mr. Ford. The opinion was expressed that the ideas of those who had taken part in the conference were not yet sufficiently crystallized to warrant formal statement; also that it was unwise to add to the number of societies devoted to city affairs, particularly as the membership of a city planning society, if one were formed, would be composed of individuals attached to the various existing societies. It was, therefore, recommended that the work of the past two years be continued by means of conferences. This recommendation was adopted. It was agreed to be the sense of the meeting that the name of the conference be changed from Annual Conference on City Planning and Congestion of Population to American Conference on City Planning. It may be added that Mr. Flavel Shurtleff, 19 Congress St., Boston, is Secretary of the executive committee.

LOW-PRESSURE STEAM TURBINES for air compression are described by J. W. Sheperdson, of the Cambria Steel Co., in "The Engineering Magazine." The low-pressure turbine is driven by the exhaust steam from an ordinary steam-driven air-compressor in its passage to a condenser. On the same shaft with the turbine is a multi-stage blower, or air-compressor, similar to those described in Engineering News of Jan. 20, 1910. This compressor delivers air under moderate pressure to the air-intake pipe of the steam-driven reciprocating compressor, and the air passes through cooling coils on its way, so that the heat of the preliminary compression is absorbed.

The Planning of Undeveloped City Areas.*

By NELSON P. LEWIS,† M. Am. Soc. C. E.

In all cities the world over the older portions have grown from small beginnings, and the street plan which has been the result of this growth has been largely the result of chance, with an entire lack of appreciation of the essentials of a city plan, and with a failure to foresee the future growth of the city.

It occasionally happens that a city is created upon a site deliberately chosen for a particular purpose, such as the seat of government, as in the case of our National Capital at Washington, or as a manufacturing city, devoted to one particular industry, as Gary, Ind., the new city established by the U. S. Steel Corporation on the shores of Lake Michigan. In such cases an opportunity is offered to create a plan which will be peculiarly adapted to the special development which has been in mind from the start. There are a few other instances in this country where the future possibilities of cities appear to have been realized when they were first laid out, and where admirable and dignified plans have been made. Indianapolis and Detroit might be mentioned as such examples.

THE STREET PLAN OF NEW YORK CITY.—In New York City the commission created in 1807 to prepare a street plan for Manhattan Island failed entirely to anticipate the future growth of the city. This commission appeared to believe that the chief traffic of the city would be across the island from the North River to the East River. In order to accommodate this traffic, east and west streets were laid out at a width of 60 ft., with only 200 ft. intervening, while the north and south avenues, although given a more generous width, were placed from 700 to 900 ft. apart. Except for Canal St., from Broadway to the Hudson River, and Broadway, north of Madison Sq., which followed an existing highway, this plan provided no diagonal streets of any importance south of 110th St. Probably it was believed that owing to the peculiar shape of Manhattan Island, with its great length and relatively small width, diagonal streets furnishing direct routes from one section to another would not be needed. We must give this commission credit for courage in planning more than a century ago a system of streets extending to 155th St. They were believed by their contemporaries to be visionary in the extreme in assuming that there would ever be any use for these streets on the upper part of the island. We cannot, however, credit them with having sufficient foresight to enable them to anticipate the marvelous development which was to take place on Manhattan Island and the other territory surrounding New York Harbor. The city having grown with great rapidity and the erection of very tall buildings having been made possible by steel frame construction, and the values of real estate having become enormous, it is now impracticable to correct mistakes or supply omissions in this original plan within reasonable limits of expenditure.

A characteristic feature of most American cities is the lack of important diagonal streets leading to some definite point of interest. These diagonals need not be long, or if they are they need not be straight for their entire distance, but different sections of them should as a rule be free from deflections, and where deflections do occur in their alinement, there should be an apparent reason for each such change in direction, which should also occur wherever possible at a point where other streets intersect, so that there shall be a series of foci, or points of interest, throughout the city. This is the charm of Washington and of Paris. One may follow any one of the numerous diagonal streets in either of these capitals and be quite sure of reaching some point of interest. A city plan which lacks these characteristics almost necessarily lacks proper sites for public or other important buildings or monuments. While, as already stated, it is often impossible to correct mistakes of planning within practicable limits of expense, there are few cities where conditions cannot be greatly improved without an expenditure which will fail ultimately to justify itself.

In most American cities whose growth has been conspicuous it will be found that additions have from time to time been made by extension of the city limits or by consolidation with other cities. Frequently these additions have already been exploited by the suburban developer; streets have been laid out and certain improvements have been made. They are often so limited in area that it is difficult to do anything but extend the already established city plan over them or accept the street lines which may have been adopted by the village or town authorities or fixed by the real-estate developer. It occasionally happens, as in the case of New York, that an extension of the city limits will include large areas where there are a number of centers of population, and that these centers are disconnected and could be absorbed in a larger city plan without serious detriment to the latter. Areas of this kind contiguous to a large city are almost invariably traversed by highways which have been established for many years and which follow natural lines of traffic. These old roads are the logical routes for transportation lines, such as electric railroads, and they could, and it would be safe to say they should, be made the controlling features of the city plan. They are generally of the ordinary country road width, that is, three or four rods, and occasionally only two rods. This width will be totally inadequate to the important part which they should play in the ultimate city plan, but they are usually allowed to remain until they have been so built up as to make a widening very expensive.

In making a plan for the annexed territory it will be found that in most cases the street system of the older city is extended over the new addition, or the crude street plans of the several villages and towns which have been absorbed by the greater city are prolonged until the different layouts meet in a confusion of unrelated street lines without system or symmetry. Then, in order to make the plans fit together, it is likely that a street will be laid out upon which they can abut, but which has no other reason for its existence. In other words, the plan of the annexed territory is the result of an attempt to enlarge and expand the old city plan or those of the existing centers of population, with no effort to study the problem as a whole or to grasp the possibilities of the territory as an integral part of a great city.

What, then, is the logical method of procedure? Do we first need an accurate topographical map of the entire area? This involves a large expenditure of time and money which, in the judgment of the writer, could be expended to better advantage. Let us assume that the unmapped areas are extensive, as in the case of those which were added to the City of New York at the time of consolidation. The first thing which it is necessary to do is to be able to determine the relative position of the different parts of the new territory and the different existing highways with respect to the remaining portions. This can only be done by a triangulation, which will establish points whose precise relative positions will be known, these points being, say, not less than 2,000 ft. or more than 5,000 ft. apart. It will then be possible to proceed with our mapping and planning in widely separated sections of the new territory with a positive knowledge of the relation of the street lines which we will establish in one section to those which we are to lay down in another.

OLD ROADS AS MAIN STREETS.—The next thing which will demand our attention is the system of existing roads. There was, and is, a good reason for these roads. Their grades may be excessive in some places, but it is probable that their alinement has been sacrificed for easy grades at the time when they were laid out, when improved roads were almost unknown and heavily laden vehicles were obliged to avoid excessive grades. These roads should form the skeleton of our future street system. In many cases it will be necessary to straighten them, and in all cases to widen them, but wherever possible the new lines should be parallel with the old ones, so that the old roads may become a part of the new street with as little disturbance as possible and without sacrificing the trees.

What width shall we give to these old roads which are to become the principal arteries of our city? In the writer's judgment they should in most cases be not less than 100 ft. in width, and in some instances even wider. It is unnecessary for us at this time to determine the subdivision of the streets which are to exceed 100 ft. in width, but if the old road was fortunate enough to have good shade trees, the original highway can probably be preserved for pleasure driving, while another section can be reserved for railroad tracks, and, perhaps, still another for automobiles, with adequate sidewalk spaces. Such an arrangement for the separation of different kinds of traffic will require a total width of about 150 ft. or even more.

These old roads which we are making the basis of our city plan may have been nearly parallel with each other or they may have been approximately radial, while the cross connections may have been infrequent or unimproved, but these cross connections will be a necessary feature of the final city plan which we have in view. They must therefore be carefully considered. They should be straight between the parallel or radial highways wherever possible and should join them at points where there are deflections. At these intersections there can well be an enlargement of the street area, creating plazas or spaces which will be available for a fountain, a monument, or some other decorative feature.

As soon as this system can be determined, the property required for the new streets, which we might, perhaps, call boulevards, should be acquired. The cost of this acquisition could properly be assessed upon the entire territory which will be developed by it, as the benefit will not be merely local, but their establishment will be the first step toward the development of the entire suburban area. If the whole system of arterial streets could be acquired under a single condemnation proceeding, it would be most advantageous.

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*A paper read at the Conference on City Planning, held at Rochester, N. Y., May 2-4, 1910.

†Chief Engineer, Board of Estimate and Apportionment, New York City.

NOT TOO MUCH UNIFORMITY AND SYSTEM.—When these controlling streets shall have been definitely determined, we need not worry about the details of filling in the spaces between them. Our city plan is fairly safe. Whether it would be advantageous to have the intervening spaces treated in a uniform or conventional manner, is questionable. It is doubtful whether a regular plan is even desirable. Is Washington more beautiful than Paris simply because its great system of boulevards is superimposed upon a rectangular street system? To one who is studying the city merely as a plan, this might seem desirable, but the interest of the average citizen is not in the map; it is in the street system itself, and it might be preferable to allow these various subdivisions to develop along lines of least resistance, without exercising too much control over them. In fact, if the treatment of these different sections varies, a more pleasing result may be attained. Here, where the topography suggests it, a serpentine system of streets may be laid out; there, a generous depth of lots, with space for gardens and ornamental planting, may be provided; here, again, we may find a group of narrower streets compactly built up with secluded courts and with small houses fronting upon a little plot of grass or shrubbery. Agreeable surprises may await us in strolling through these various sections, while a short walk in any direction will bring us to one of the system of thoroughfares where the traffic, the business and the amusements of the great city will be found. If one of these sections takes on a distinctive character, the neighboring districts will be stimulated to try and establish a character of their own.

If we attempt to establish a uniform cut and dried standard for all parts of a great city, it is more than likely that we will find that we have "leveled downward." In all large cities the individual is likely to be lost, the neighborhood feeling is unable to survive. It is frequently held that this neighborhood feeling is an evidence of provincialism, that it is inconsistent with the development of a great city and belongs only to the small town. This may be true if we leave the city as a whole to develop as an unrelated group of neighborhoods, for a comprehensive plan cannot be evolved by a town meeting, a civic association or a group of them. The creation of such a plan needs a strong hand and a central authority which will be in large degree regardless of unimportant local interests. But, the general scheme once established by a system of thoroughfares such as has been outlined, the writer believes that a great degree of latitude should be allowed the neighborhoods and the individual developers, so long as the street lines and grades they wish to establish are not inconsistent with public convenience, with an abundance of light and air, with a rational and economical drainage system, and with good sanitary conditions.

PARKS AND PLAYGROUNDS.—No reference has yet been made to a system of parks and playgrounds, and the place which such a system should have in the city plan. This omission was intentional, as the writer does not believe that a park system should be a mere incident in the plan of a city. The policy of most of our cities, and with few exceptions this policy is especially notable in New York, has been to defer the selection of park sites until the necessity for park areas has become apparent, or until the public demand for them has become so strong that it cannot be ignored. Meanwhile, the entire city plan is likely to have been covered by a system of streets, many of which must be obliterated when the parks are finally laid out. It is scarcely necessary to say that the adoption of a street plan has resulted in the conversion of acreage property into city lots with a great increase in value. This value may be to a large extent speculative rather than real, but it is a value which will be reflected in the amount which the city must pay in the acquisition of the property.

It must be admitted that parks are a necessary part of any city plan, and that, therefore, they should be given a conspicuous place in designing a city street system. The writer, however, is disposed to go somewhat further and to maintain that instead of adapting the park system to the street system, the former should to a considerable extent control the latter. In other words, one of the first subjects which should receive serious consideration in the preliminary study of a city plan is that of available park sites. If there is a particular bit of woodland, an elevation with a commanding outlook, or even a piece of low-lying land traversed by a stream, which have not yet been cut up into building lots, they can be most advantageously set aside at this time as future parks. These reservations should be scattered over the entire area so that there will ultimately be some open space within convenient walking distance of every resident of the city. These parks should be connected by adequate roadways, not necessarily straight or even of uniform width, but contracted where the topography would involve expensive construction and again expanded to include a small area which might ultimately become a most attractive feature of our park and parkway system. As we are dealing with a territory which is at the present time suburban and where detached houses are likely to be always a characteristic feature, it will not be necessary to provide large park areas, and yet parks of considerable size may be exceedingly desirable as playgrounds and places of recreation for those living in the most congested areas in the older parts of the city, especially if they are so located as to be easily reached by existing or prospective transportation lines. It may be deemed unwise, or even foolish, to assume that parks will be ultimately needed in the particular localities which we have selected. The city may not grow in the direction and along the lines which we have assumed, but, while it must be admitted that the manner in which any city will develop and expand cannot be predicted with any degree of accuracy, it is not unlikely that this expansion will follow the lines of least resistance, and if encouragement is given by a judicious selection of park areas connected by adequate roadways, and if the controlling features of our street system are laid out along the lines already indicated, the future development is almost certain to follow these lines, and the result will be a city plan which will appear logical and reasonable, rather than a mere accident.

MINOR PUBLIC BUILDINGS.—In a territory such as we have been considering it may be useless to speak of the grouping of public buildings, for the important municipal centers will have already been established and will not be moved. There are, however, minor public buildings, such as schools, libraries, public baths and comfort stations, police stations and fire houses, for which provision must be made, and it would be most desirable to set aside here and there what might be termed "municipal blocks," upon which buildings of this kind could be grouped in a very effective manner. Our park areas and our "municipal blocks" should be acquired at as early a date as possible. It is often very difficult to justify a public expenditure in advance of actual needs when so many demands are being made for urgent municipal improvements in the older portions of the city, but a little foresight in this respect would undoubtedly save many times the sums which will inevitably be required to correct mistakes owing to lack of foresight in making provision for what is sure to be required some day. The writer knows of no instance of the formulation and execution of a policy such as has been outlined, but it appears to be so reasonable and logical that it is a matter of surprise that the problem of making a city plan has never been undertaken in this manner.

It is not submitted as a rule to be followed in city planning, but as a suggestion which may be thought worthy of serious consideration and discussion, in the hope that it may be of some slight assistance to those who are confronted with a problem of this nature.

The Holding Method of Milk Pasteurization.

By CHARLES E. NORTH.*

The design of apparatus to apply and to remove the heat to pasteurize milk on a large scale, as is now being done for portions of the milk supply of a number of important cities, presents some interesting problems to the engineer. The accompanying brief account of the evolution of what is known as the Holding Method of Milk Pasteurization, accompanied by a brief description of the apparatus now used for the purpose, and of the results obtained with it as compared with those from momentary or commercial evaporation, may interest some of the readers of Engineering News.

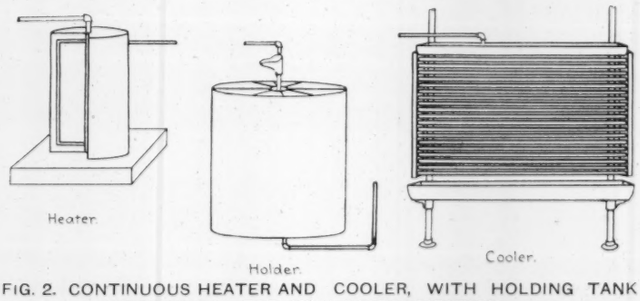


FIG. 2. CONTINUOUS HEATER AND COOLER, WITH HOLDING TANK INTERPOSED, FOR MILK PASTEURIZATION.

(The ordinary continuous or commercial pasteurizer lacks the holding tank.)

In order that the demands on pasteurizing apparatus now being made by boards of health and by sanitarians may the better be understood I quote certain resolutions passed by the Department of Health of the City of New York on Dec. 8, 1909, as follows:

(1) Only such milk or cream shall be regarded as pasteurized as has been subjected to a process in which the temperature and exposure conform to one of the following: 158° F. for three minutes; 155° F. for five minutes; 152° F. for ten minutes; 148° F. for 15 minutes; 145° F. for 18 minutes, and 140° F. for 25 minutes.

(2) On and after March 1, 1910, milk or cream which has been heated in any degree will not be permitted to be sold in New York City unless the heating conforms with the requirements of the Department of Health for the pasteurization of milk or cream.

(3) All forms of apparatus used in the pasteurization of milk or cream shall be automatic and shall be equipped with automatic temperature and time-regulating and recording devices. Applications for permits to pasteurize milk or cream will not be received until all forms of apparatus connected with the preparation of the milk or cream for sale have been tested and the process approved by the Board of Health.

The resolutions just quoted contain certain specifications to which apparatus must conform in order to carry out the heating of milk in a way which will entitle the product to the use of the term "pasteurization," and furthermore the Board of Health declines to permit milk to be heated in any other way. The resolutions of the Board plainly assume that apparatus exists by which the temperature and duration of the heating of milk can be accurately controlled and automatically regulated and recorded. These resolutions, in a word, mark official recognition

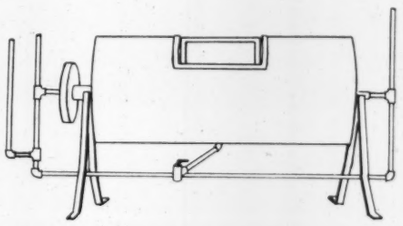


Fig. 1. Old-Style Tank Heater for Milk Pasteurization.

of the process which has come to be known as the Holding Method of Milk Pasteurization.

The advent of this heating method has been unheralded and up to this time its origin has been obscure and the results of its work have been unrecorded. The process is one, however, which for the first time puts the pasteurization of milk in large quantities on a scientific footing and makes it possible for the large milk dealer to adhere to scientific standards and for health authorities to establish such standards. The process means so much for the purification of infected milk supplies of cities that in the opinion of the writer it is well worthy of the attention of physicians, sanitarians and those in charge of public health.

The question whether pasteurization is a proper remedy for infected city milk supplies is being settled in the affirmative. Without entering into a discussion of the importance of sanitary measures at the sources of milk production it is sufficient to say that the majority of sanitarians are coming to recognize that the public health can be best protected by the immediate pasteurization of the larger part of municipal milk supplies. It is necessary, therefore, to consider by what method pasteurization of such large quantities of milk can be accomplished. Theoretically, it seems a simple thing to heat milk to the proper temperature for a sufficient length of time to destroy any infectious bacteria which it may contain. Practically, there are many serious difficulties to be overcome. In the laboratory, milk is commonly heated in glass flasks, placed in steam sterilizers for half an hour or more, and the operation is repeated on three successive days, until the milk is rendered sterile. In the household, milk in large glass bottles or in small infant feeding bottles can be pasteurized by immersing them in hot water, and several convenient forms of apparatus are in use for this purpose. In the infant milk depots which have been established a considerable number of the

*30 Church St., New York City.

small infant feeding bottles containing milk, are placed in large steam chests or sterilizers which are slowly heated up to the required temperature and slowly cooled down. These methods are totally inadequate, however, for use in the pasteurization of large quantities of milk. The physical obstructions incident to the use of glass bottles, steam boxes, hot-water tanks, and the intermittent and interrupted steps of the operation as conducted on a small scale, make it entirely impossible by such methods to pasteurize large quantities of milk and complete the operation during the few hours available before the early delivery demanded by milk consumers. It is not an uncommon thing for a single dealer in cities to handle from 50,000 to over 150,000 quarts of bottled milk between the hours of 11 p. m. and 3 a. m. each day.

The first attempt made by milk dealers to pasteurize their product consisted in the use of tanks in which the milk was slowly heated in bulk by steam or by a hot-water jacket. The Potts pasteurizer (Fig. 1) is one type of such a machine. It is evident that the filling and emptying of such tanks and the slow heating form an intermittent process consuming much time. The obstruction caused by these delays resulted in only a very limited use of the process.

From 1890 to the year 1900 a large variety of machines were invented for the rapid and continuous heating and cooling of milk. These machines have been variously known as Continuous Pasteurizers, Instantaneous Pasteurizers, Flash Pasteurizers, etc. By the use of pipes, cylinders and metal surfaces over which the milk flows in thin sheets the temperature of the milk can be quickly changed. All of these forms of apparatus consist chiefly of two parts, namely, the heater and the cooler [essentially the same apparatus as is shown in Fig. 2, except that the intermediate tank or "holder" there shown was not used.—Ed.]. The milk flows in a continuous stream into the heater where it remains for a period of from a few seconds up to two minutes and then flows rapidly onward to the cooler in which it is quickly cooled. It remains there for the same short period of time and flows onward into tanks or bottles.

These rapid and continuous pasteurizers first gained their popularity with large milk dealers in this country about the year 1900. The chief reason for their adoption was because the treatment killed the bacteria which caused the souring of milk and thereby stopped the heavy losses from souring to which the large dealers were subjected during the hot months. At that time, however, public sentiment was so strongly opposed to pasteurization that the process was often conducted secretly and consumers were unaware that they were buying milk which had been so treated. Secret pasteurization was carried on in Philadelphia, Newark, New York and a number of other cities for several years, until the dealers, found it expedient to publish the fact that their product was pasteurized. I may state in passing that in each instance the publication was followed by a great increase in the volume of business.

In 1906 the writer raised the question, verbally and by correspondence, among milk dealers and among the manufacturers of pasteurizing apparatus, as to whether the machines in use could be depended upon to destroy the tubercle bacillus. A tabulation of the work done by a number of authorities showed that the time and temperature used by these rapid and continuous machines did not correspond at all with the time and temperature which laboratory experiments had demonstrated to be necessary for the destruction of the tubercle bacillus. A temperature of 158° F. for a period of 40 seconds was the common practice by the large milk dealers, and most of the pasteurizing machines were manufactured for the purpose of treating the milk in that manner. In contrast, such authorities as Theobald Smith, Russel and Hastings, and others, as the result of laboratory experiments, placed 140° F. for a period of 20 minutes, as the minimum, while some authorities demanded much higher temperatures for periods of time ranging from several minutes to one hour to destroy the tubercle bacillus. It was evident that an increase in temperature or extension of the duration of heating was necessary to insure the destruction of the infectious bacteria in milk, but an examination of the continuous machines in use showed that none of them were mechanically arranged so that the duration of heating could be extended. The temperature could not be raised to the extent necessary without at the same time destroying the properties of the milk and preventing the cream from rising in the glass milk bottles. The rising of the cream and the appearance of a distinct line between the milk and the cream in the glass bottles delivered to the milk consumer had become such an important commercial factor that for business reasons a process which would destroy this cream line could not be adopted by the large milk dealer.

Since the temperature could not be raised without injury to the milk the use of lower temperatures and the extension of the duration of heating was the only alternative. A survey of the work of the various authorities as to the effect of temperature on the bacteria and on the milk itself seemed to show that if the milk could be heated to 150° F. for 30 minutes the tubercle bacillus and other species of bacteria causing disease commonly found in milk would be destroyed while the milk itself would sustain

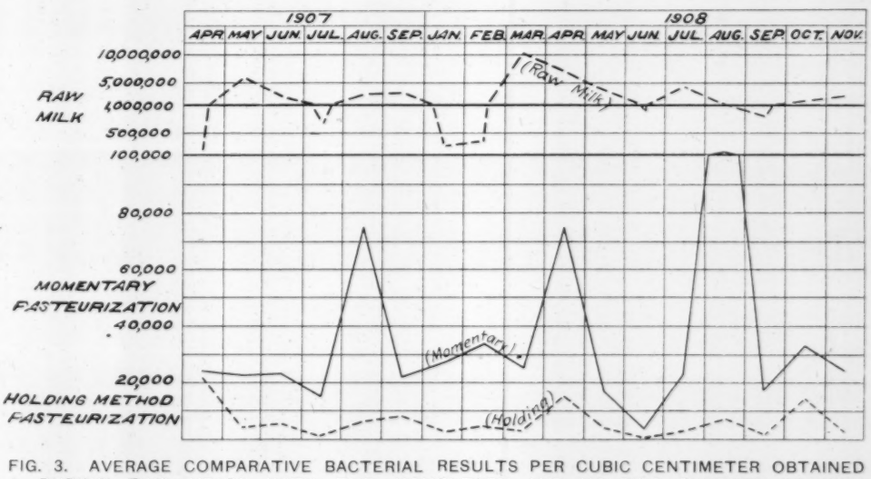


FIG. 3. AVERAGE COMPARATIVE BACTERIAL RESULTS PER CUBIC CENTIMETER OBTAINED DURING TWO YEARS WITH THE MOMENTARY AND HOLDING SYSTEMS OF MILK PASTEURIZATION.

(The same scale has not been used throughout for expressing bacterial results; see text.)

but slight if any injury, and the cream would continue to rise in the glass milk bottle. The writer therefore recommended that milk be pasteurized at 150° F. for 30 minutes.

The temperature of the machines in use could be readily lowered by regulating the steam and hot water supplying the heater. The duration of heating, however, could not be extended, as all of the machines were built for rapid flow of milk and had a capacity of only a few gallons of milk at any one time.

The heaters of the rapid machines, however, could not be excelled for heating purposes as their design was in all types one which insured a thorough and almost instantaneous heating of every particle of milk passing through them. In that respect they excelled the old-style tanks in their ability to quickly and thoroughly apply heat to large quantities of milk.

The problem, then, was not how to heat the milk, but how to keep it at a warm temperature during the required period. Obviously some system of storage for the heated milk was the only solution.

The writer suggested to the manufacturers of dairy apparatus and to some of the milk dealers that a storage tank for heated milk be added to the continuous pasteurizing apparatus. In a word, this suggestion was to combine the old form of tank pasteurizer with the modern rapid continuous machine, by interposing the tank between the heater and the cooler of the modern machine so that the hot milk going from the heater would be side-tracked and held in the tank in its heated condition for the length of time necessary to destroy the tubercle bacillus and other forms of pathogenic bacteria commonly found in milk. (Fig. 2.)

Such a process as this would be continuous. There would be no intermission after the apparatus was once started. The milk received by the heater would be continuously discharged into the storage tank and from there continuously flow to the cooler. It would not delay the operation of handling milk as ordinarily performed by the large milk dealer, with the single exception that the process of pasteurization would have to be commenced one-half hour earlier to allow the length of time necessary for the hot milk to remain in the storage tank. After the storage tanks began to discharge milk, however, the operation would be a continuous one.

Theoretically the plan seemed sound and to put it into operation it only remained to find a proper tank which could be depended upon to receive a continuous flow of hot milk from the heater, hold each particle of milk the required length of time, and discharge it continuously to the cooler. There were certain mechanical difficulties in the way of this, due to the fact that in the various forms of tanks designed for the reception of milk and other liquids, currents would be formed in spite of the use of baffles and other means to prevent them. Such currents would, of course, prevent each portion of milk from being heated for the same length of time.

These mechanical difficulties were entirely overcome by the ingenious invention of a mechanical engineer who produced an automatic holding tank for the purpose described. This was built in the winter of 1906, and by combining it with one of the continuous units of pasteurizing apparatus then in use there was formed the first complete apparatus for pasteurizing milk by the holding method. This was installed in a milk station of one of the large milk dealers in New York City in the Spring of 1907.

The simplicity of this plan made it difficult to believe that the scheme had been up to this time overlooked by those who for many years had been making a study of the heating of milk. Further investigation showed that the plan was not original with the writer but that it had been suggested at least twelve years previously by a prominent dairy expert. In the year 1895 a book was published by a Norwegian dairy expert, J. H. Monrad, entitled "Pasteurization and Milk Preservation," which contained this statement:

STORAGE TANKS.

In view of the assumed necessity of keeping the milk or cream at a high temperature for 20 or 30 minutes if it is to be sold and not manufactured, and in view also of the difficulties of heating all the milk in a body when we have to handle large quantities such as must be handled by milk-shipping stations, if pasteurization is

ever to be introduced generally, I have suggested the following plan:

Use any continuous heater which you find best, but instead of running the milk directly to the cooler, run it into a storage tank which should hold one-third of the hourly capacity of your heater and cooler if you desire to keep the milk for 20 minutes at the high temperature, or one-half if you want to keep it 30 minutes.

This tank may either be built with a water space filled with water at 155°, or, better still, be properly insulated so as to hold the temperature within 5°.

By having one partition in the tank and two attached to the cover, the milk is compelled to go to the bottom first, then up, then down, and at last up and out to the cooler, and I challenge bacteriologists to show any reason why this arrangement does not solve the problem of combining the continuous apparatus with the strictest bacteriological demands.

In addition to this statement the author published an illustration of a continuous pasteurizing apparatus with a storage tank containing baffles interposed between the heater and the cooler.

This valuable suggestion, however, was not recognized by bacteriologists or sanitary experts at that time and was not put into operation by milk dealers. The writer can only claim, therefore, to have played some part in resurrecting this idea from its obscurity and to have been the means of stimulating the mechanical engineer to invent an automatic tank and the milk dealer to put the apparatus into operation.

The time and temperature at which the machine was operated were, at the writer's suggestion, made 150° F. for 30 minutes. Regular bacteriological analyses were made of the raw milk entering the machine and of the milk after treatment. This was done by taking samples of milk as the milk entered the machine and as it left it. In addition to this a set of parallel tests were made of milk received from the same sources and pasteurized by the ordinary continuous process (without the use of the storage tank) by which the milk was heated to a temperature of 158° F. for a period of 40 seconds. These parallel tests were conducted twice weekly for a period of over two years under the writer's direction, and many of them were made by the writer personally. From among the many tests which have been made, some representative results have been selected in which are fairly shown the efficiencies of the two methods of pasteurization. Table I. contains the results of a series of tests made of samples of milk taken directly from the continuous pasteurizer operated with and without the use of a storage tank.

TABLE I.—COMPARATIVE BACTERIAL RESULTS FROM MOMENTARY AND HOLDING PROCESSES OF PASTEURIZING MILK.

	Raw milk.	Momentary process.	Holding process.
	6,000,000	14,500	2,000
	10,000,000	12,000	1,200
	1,500,000	27,500	1,600
	4,000,000	25,000	1,700
	9,000,000	37,000	1,300
	3,000,000	15,000	900
Average.....	5,583,000	21,800	1,450

From this table it will be seen that the process without the storage tank, in which the milk was heated to 158° for 40 seconds, gave an average reduction of 99.6%, and the milk heated by the apparatus with the storage tank in operation to a temperature of 150° for 30 minutes showed a reduction of 99.99%. Expressed in another way, by the use of the holding tank 93% of the bacteria remaining in the milk after treatment by the ordinary continuous process, were destroyed.

In addition to the tests of samples taken from the machines, a large number of samples were taken from cans as delivered to the milk station from the railroads, from bottles containing milk pasteurized by the ordinary continuous process, and from bottles of milk pasteurized by the apparatus with the storage tank in operation. Table II. presents a series of tests giving typical results of these examinations:

TABLE II.—COMPARATIVE NUMBER OF BACTERIA IN RAW MILK IN CANS FROM CREAMERIES, AND IN MILK AFTER TREATMENT BY MOMENTARY AND BY HOLDING PROCESSES OF TREATMENT.

	Cans from creameries.	Bottles from momentary process.	Bottles from holding process
	320,000	50,000	1,500
	10,000,000	35,000	1,600
	1,670,000	52,000	1,100
	940,000	30,000	4,500
	360,000	48,000	4,000
	330,000	30,000	2,400
Average....	2,270,000	40,833	2,518

From this table it is evident that the bottled milk ready for delivery to the market, by means of the addition of the storage tank to the ordinary pasteurizing apparatus, contained on the average only 5% of the number of bacteria found in the milk pasteurized by the ordinary process.

The regularity with which the storage tank produces results is remarkable. All of the tests which have been made on these machines at semi-weekly intervals for a period of two years have been averaged for each month. These figures are drawn up in the form of curves in the diagram, Fig. 3.

In constructing the above diagram it was necessary to reduce the line of the ordinates so that each division in the upper part of the diagram represents a number of bacteria many times the number represented by the divisions in the lower part of the diagram. This was because of the enormous numbers found in the examinations of the raw milk. For instance, the distances between the line indicating 100,000 and 1,000,000 bacteria should in fact be ten times as great as the distance between the line at the bottom of the diagram and the line opposite the figure 100,000. It is noteworthy that the raw milk delivered to the pasteurizing machines remains above the line indicating 1,000,000 bacteria per c. c. during most of the period. The continuous black line shows the number of bacteria contained in milk pasteurized by the ordinary rapid process averaged for each month of the test. This line shows large fluctuations and it will be noticed that these follow to some extent the fluctuations in the numbers of bacteria found in the raw milk. This is not the only reason for the fluctuations, however, as they are undoubtedly due also to the fact that this machine was operated without the use of a thermo-regulator and that therefore the temperature of operation could not always be accurately maintained at the same point. The dotted line in the lower part of the diagram indicates the average of all of the tests made during each month of milk pasteurized by the use of a storage tank. During most of the period the number of bacteria often averaged less than 10,000 per c. c. and during a large portion of the period the average was less than 5,000 per c. c.

The total number of bacteriological analyses made of raw milk delivered to the machines during the entire period was 1,344. The total number of bacteriological analyses made of milk pasteurized by the ordinary rapid continuous process was 606. The total number of tests made of samples taken directly from the machine and of bottled milk produced by the use of the storage tank during the entire period was 703. The bacteria per cubic centimeter found in all of the examinations of these three classes of milk were as follows: raw milk, 2,750,000; pasteurized milk, 37,000 by the momentary and 6,000 by the holding process of pasteurization.

Bacteriologists in other places have made a number of analyses of milk from various types of pasteurizing apparatus and some few analyses have been made of milk pasteurized by the use of storage tanks. The results of these analyses have in the majority of instances been favorable to the efficiency of the storage tank. But there have been some results reported in which the use of the storage tank seemed to be a disadvantage. It seems to the writer that the knowledge gained by any single test or by any small series of tests is necessarily subject to the peculiar circumstances attending the tests at the time and that the results are not nearly so reliable as those to be secured by compiling the statistics of a very large number of tests, taken under all circumstances and covering a long period of time. The statistics covering such a long period produce a set of averages which can be relied upon as giving a true indication of the efficiency of the process employed.

In the experiments reported above, the operation of the machines, the cleaning of the apparatus and of bottles, were all performed by the regular employees of the milk station in the course of their daily duties. Consequently, the results do not represent conditions where extreme or unusual precautions were observed, but they represent ordinary working conditions such as can be easily maintained in any well-conducted milk station. It would be interesting to know what results could be secured by the use of this method when operated with extreme care and under scientific conditions.

There is, of course, no question but that the quality of the raw milk which is delivered to the machines for treatment has much to do with the final result. If, for instance, raw milk containing only 100,000 bacteria per c. c. should be treated by this process, the final product would contain only a few hundred bacteria.

At the present time more than 150,000 quarts of bottled milk are delivered in New York City which have been pasteurized by this method. The process has been adopted in Washington, Philadelphia, Boston, Chicago, St. Louis, Omaha and in other cities.

By the method described the large milk dealer for the first time in the history of the milk industry, is enabled to conform to any requirements which may be demanded of him by health authorities in the matter of time and temperature. The temperature can be reduced or increased to any desired degree, by regulating the heater. The time can be made short or long by adjusting the storage tank to accommodate the desired flow of milk. Milk can be pasteurized in unlimited quantities and just as efficiently as by any one of the processes in use in the laboratory or in the house. The process is one, therefore, which places the pasteurization of city milk supplies on a scientific basis and its use seems destined to play an important part in the protection of communities against milk infections.

The Legal Liabilities of Levee and Drainage Districts.*

By J. V. WADDELL.†

The purpose of this paper is to describe a case which involves the liability of a levee district for damages resulting from improvements made by the district in the Kaskaskia River bottom.

In 1902 the Vandalia Levee and Drainage District was organized in Fayette County, Illinois. The improvement contemplated was the building of a levee on and along the east bank of the Kaskaskia River, from the mouth of Lynn Creek, south and southwest for about 12 miles. The upper end of the levee was to connect with a high bluff and at the lower terminus, space was left between the levee and the bluff for the outlet of a dredge ditch into the river.

The levee was built to form a continuous embankment from end to end, its purpose being to protect the entire area of land between the east side of the river and the east bluffs from the overflow of the river. No provision was made for inlets at any place. A system of dredge ditches was planned also, to intercept the water from the bluffs and from the incoming streams, carrying it to the lower end of the district before it could flood the bottom land. After considerable litigation the district organization was perfected, and work was started on a levee with a 4-ft. top, slopes 1 on 1½, and averaging 8 ft. in height. The work was started in September, 1904 and practically completed November, 1905.

The river bottom along the line of the district averages 1½ to 2 miles in width, the boundary being a well-defined bluff line, occasionally broken up by a small creek inlet. The river itself lies nearer the west bluffs, leaving the greater portion of the bottom land between the river and the east bluffs.

The Kaskaskia River is probably one of the most crooked streams in Illinois. Long bends, in oval shape, carry the water around for a distance of nearly a mile to a point only 1,000 ft. from the upper end of the bend. This condition cuts down the carrying capacity of the stream greatly, and at the first rise, the river breaks from its banks and floods the surrounding bottom lands, in times of spring floods often being two miles in width. Before the construction of the levee, the entire bottom ground east and west of the river was subject to overflow, no great difference in time of flooding being apparent upon either side.

Within a year or so after the completion of the levee, complaints were heard from the landowners on the west side of the river to the effect that their ground was being flooded with ordinary spring floods, deeper and further back than ever before.

It should here be explained that the river overflows come at different times and cause different degrees of

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, at Cairo, Ill., Jan. 26-28, 1910.

†Civil Engineer, Vandalia, Ill.

damage. In the early spring a heavy overflow is expected (from February to April). The river is apt to overflow both banks to a considerable depth, but as the crops are not yet in the ground, no great damage or loss results; the flood subsides, the ground becomes fit for cultivation and although the planting may be late, the fertility of the bottom soil is so great that the bottom crops are soon on a par with the upland crops. In June or July we generally have heavy rains and that is the time when great damage is done. The river overflows quickly, the corn is partly covered with water and as the water slowly begins to recede, the hot sun quickly wilts the tender corn and in a few days perhaps hundreds of acres of crops are totally lost.

The early spring floods are apt to overflow the levee and inundate the land on both sides of the river. But the June or July floods do not usually break over the levee, and at such times one may see on the east side flourishing crops, and on the west side an unsightly mass of decaying vegetation. This condition brought about the complaints from the land owners on the west side.

Suit for damages was filed in the Circuit Court of Fayette County in May, 1907, by the owners of a small tract of land. The declaration stated that the plaintiff owned lands lying on the west side of the river at the upper end of the levee, and that before the building of the levee the lands were not subject to overflow by ordinary freshets; and that since the building of the levee, the land was overflowed, crops were destroyed, the soil was washed away and the land had depreciated in value and had been rendered unfit for farming purposes.

In answer to this the defendant set up, in part, that the drainage district is an involuntary quasi-public corporation and that as such, no action can be maintained against it for damages, nor can it be held responsible for the wrongful acts or negligence of its officers; also that one landowner may levee against overflow waters of a river and prevent the same overflowing his land, without being liable in damages to another landowner because of increasing the overflow on such other lands.

Judgment was rendered against the plaintiffs and on appeal to the Appellate Court judgment was confirmed. Appeal was then taken to the Supreme Court, where the case was reversed and remanded. In the written opinion, the substantial question raised is whether the defendant is liable for the damages sustained by the plaintiff. It is held that if an individual owner of land, where the levee was built, had done the same acts as the defendant he would have been liable for the consequent damages.

The placing of an obstruction in a water course lays one liable for resulting damages, and the principle was applied by the Court alike to obstructions to the natural flow of surface waters and to natural water courses, thereby placing no distinction between intermittent flowing surface waters, and water flowing continuously in a natural water course. Authority was cited by the Court to show that:

> A riparian proprietor may erect any work in order to prevent his land being overflowed by any change of the natural state of the stream and to prevent its old course being altered, but he has no right, for his greater convenience and benefit, to build anything which in time of ordinary flood will throw the water on the grounds of another proprietor so as to overflow and injure them.

In regard to the district being an involuntary quasi-public corporation and not liable to respond in damages for any of its acts, the Court held that there is a distinction between such corporations which are liable for the negligent acts of their agents or servants, and those which are not. Those which are not liable are mere political or civil divisions of the state, created by general laws to aid in the general administration of the government. Those which are liable are the ones having privileges conferred upon them at their request, which privileges are a consideration for the duties imposed upon them; to this latter class, the drainage district belongs.

While this was only a small tract of ground damaged, the question at issue was far reaching, and already several other suits have been filed, involving several hundred acres.

The question of right and responsibility of damage being settled, the remedy for the existing trouble is already being sought. Levee districts will continue to be organized in the river bottoms, as land capable of producing great crops is too valuable to let lie in disuse through fear of legal entanglements. The engineers, keeping in mind the legal rights of such districts, must devise such a plan that the land may be redeemed and damages equitably settled or avoided at the outset.

A newly organized levee district must either prepare at the beginning to pay a money consideration for the lands damaged, or prepare plans of improvements such that the overflows in crop times shall be taken care of without causing a greater overflow on the unprotected side than there would have been in a natural state, before improvements were made. A plan suggested is that instead of building a continuous levee from the upper to the lower bluff, a head-gate should be constructed at the upper end of the levee, of such height and cross section that when the river rises to a stage where overflow is imminent a large volume of water can be let into a dredge ditch built along the bluff line inside the protected area, carrying this water down to the river outlet below. This would afford a relief for the back water.

A more important matter in planning such districts is to enlarge the old waterway by cutting off bends in the river, giving the water a chance to keep in a well defined channel, increasing the velocity of flow, and letting the natural process of erosion cut a channel of sufficient capacity to care for the flood waters. Testimony was brought out in the trial showing that the upper watershed of the Kaskaskia River had been greatly improved by tiles and open ditches, probably 150 miles of such improvements having been made in the last five years. The natural result is that flood waters from above are brought down from 24 to 36 hours earlier than they were before such improvements were made, and on reaching the unimproved part of the river the velocity of flow is reduced and backwater at once floods the land.

A movement has lately been started to throw the entire river bottom area of Fayette County into one organization, placing the many drainage districts which have already been formed under the control of one drainage board. When such control has been secured assessments will be placed on the entire area, and the funds used to improve the river by cutting off bends and deepening the channel. It is thought that in this way flood waters can be cared for without the need of levee protection, provided that enough lateral ditches are built, by the sub-districts, to carry the bluff water to the river fast enough to prevent overflow. It is a question whether such a plan could be carried out under our present drainage laws, and some new legislation may be needed pertaining to this particular plan of organization.

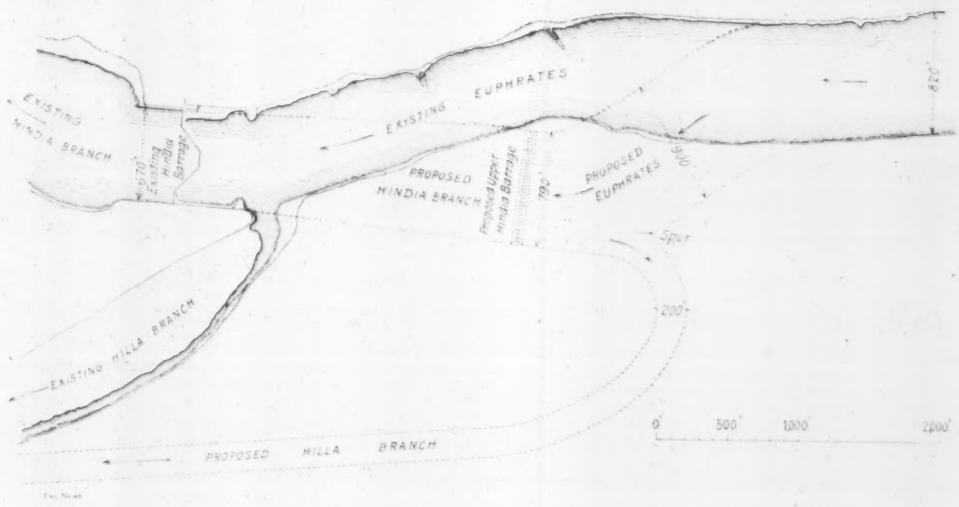
The ultimate remedy is to look to the state for aid in improving the entire waterway of the Kaskaskia River. Short stretches of river improvement here and there will not settle the matter and it is only by commencing at the river mouth and improving the entire waterway, that the Kaskaskia River valley will finally be reclaimed.

As a summary of the facts in this case, we know: (1) that a levee and drainage district, from the fact that in organization it receives certain rights and privileges from the state, becomes a corporation which is liable to respond in damages for injuries received by other lands through improvements made by the district. (2) That in cases regarding obstruction of waterways, there is no distinction made between obstructions to continuous waterways and obstructions to intermittent surface waterways, and that in planning levee district improvements provision should be made either to make compensation to lands liable to damage, or to construct improvements such that relief from river overflows will be provided for in such a way that unprotected lands will not suffer a greater overflow than they were subject to before improvements were made.

SLACK TENSION MEMBERS IN TRUSSES are tightened up in a novel way by a method brought out recently by the firm of A. Hasenkamp of Essen, Germany. It involves the use of Thermit for heating a short section of the member to white heat, and screw clamps attached either side of the heated section and joined by take-up screws for upsetting the heated part by longitudinal pressure. In use, the clamps are first put on the member, 12 to 18 ins. apart, then a separable mold or jacket is placed around the middle part of the length between the clamps, steel melted by the Thermit process is run through the jacket, thereby heating the enclosed piece of the bar, and finally the tension screws which connect the two clamps of a set are drawn up, which upsets the heated part of the bar. The process has been actually applied to several bridges, in which non-adjustable counters had become slack. It was even found possible to upset the bars enough to place them under tension in normal condition. [From "Zentralblatt der Bauverwaltung," March 19, 1910.]

A Novel Plan for Diversion of an Irrigation Canal from a Silt-Carrying River.

As some of our readers are aware, Sir William Willcocks, the distinguished English irrigation engineer, has been for some time engaged in the planning of great works for irrigation in the valley of the Euphrates River in Asia. This is a region where, according to the best evidence, one of the earliest civilizations of which tradition gives information had its seat. It is probable that the people who then flourished in this region relied largely on irrigation works for carrying on their agriculture. In connection with the plans for the construction of irrigating canals, Sir William has developed a novel scheme for leading off an irrigation canal from a silt-carrying river in such a manner as to lessen the likelihood to the silting up of the canal. He writes to us from Bagdad, under date of March 21, 1910, as follows:



PLAN OF THE EUPHRATES RIVER AT THE HINDIA BARRAGES, SHOWING A SCHEME FOR DIVERSION OF AN IRRIGATION CANAL PROPOSED BY SIR WILLIAM WILLCOCKS.

I ask you kindly to publish this letter and plan in your paper and invite criticisms from irrigation engineers on the proposed alinement of the Hilla branch of the Euphrates. I have omitted the locks on the plan so as not to confound issues.

Artificial branches of this kind are ordinarily taken off from above regulators or otherwise, in the direction of the current of the main river. I propose the opposite. For years I have made a close study of silt deposits in canals, and my observations have led me to the conclusion that we engineers choke our canals with silt (except in cases where we have steep slopes at our disposal) because we do not imitate nature.

All natural small branches with gentle slopes which do not silt up, take out of the main stream in the manner I propose for the Hilla Branch. They moreover take out from shoal water with the main current of the river on the opposite side, and with the river wider at the point of departure than the normal section. Of course, I am speaking of muddy or sandy rivers.

At the Hilla Branch we have a slope of 1-12,500 and a depth of water of 10 ft., while the Euphrates has the same slope with a depth of water of 25 ft. I propose, moreover, a bar across the head of the branch so that none of the bottom water of the Euphrates will enter the branch.

At the existing Hilla Branch head, a triangle of silt was deposited every year, which was annually removed, and nature has revenged herself by practically obliterating the branch with silt. The absence of a bar at the head has moreover resulted in a very deep narrow channel which takes in the muddy bottom water of the Euphrates.

Thirty years ago the Hilla or Babylon branch had five times the water of the Hindi branch. Today it has barely one-tenth, and that only in flood.

Yours truly,

W. Willcocks.

Hiram Snyder.

Hiram Snyder, who has been prominent in the Portland cement industry for more than 45 years, died Sunday morning, May 8, at his residence on Madison St. in Brooklyn, N. Y., after an illness of twelve days. The accompanying photograph, although taken about 30 years ago, is a fairly true likeness of Mr. Snyder as he appeared just previous to his last illness.

Mr. Snyder was born at Rosendale, N. Y., in 1842, and became interested in the cement industry while yet a young man. One of his early positions was with the New York & Rosendale Cement Co., of New York City, of which he was formerly Secretary and Treasurer. It was this company which supplied the cement used in the construction of the towers and anchorages of the Brooklyn Bridge. At the time of his death, Mr. Snyder was the senior member of the firm of Hiram Snyder & Co., of New York City, and was also President of the Eclipse Lighterage & Transportation Co.

He was a charter member and the first President of the Building Material Exchange, of New York City, and had served as its Treasurer for more than eleven years. He was a member of the Building Trades Employers' Association and was prominent in several fraternal orders and societies.

Mr. Snyder's widow and his two daughters, Miss Bertha L. Snyder and Mrs. Wm. H. Hendrickson, survive, and there are also three grandchildren. His son-in-law, Mr. Wm. H. Hendrickson, was his business partner, at the time of his death, in the firm of Hiram Snyder & Co.

AN AUTOMOBILE FIRE-ENGINE TIRE BURST May 5 at Macon, Ga., while the engine was making a run to a fire. The machine was wrecked and three firemen were killed.

A LOADED COAL CAR RAN AWAY on a grade on the Seattle, Renton & Southern Electric Ry., April 30, at Rainier Beach, seven miles from Seattle, Wash., and collided with a steel passenger car which was going up the hill. Twenty passengers were injured, three fatally. The coal car became uncontrollable while ascending the steep grade ahead of the passenger coach.

A VALVE IN A STEAM MAIN BURST May 7 in the boiler-room of the sea-going tug "Cape Charles," which was making her trial run on the Delaware River. Four men were killed and four others suffered severe scalds. The tug was built at John H. Dialogue & Son's shipyard, Philadelphia, Pa., for the Philadelphia, New York & Norfolk R. R.

THE BOILER OF A PASSENGER LOCOMOTIVE exploded May 6 at Pittsburg, Pa., on the Pennsylvania R. R. The boiler was torn from its trucks and thrown 250 ft. from the track. The engineer was killed and the fireman was badly injured. Several passengers in the first coach were cut by flying glass.

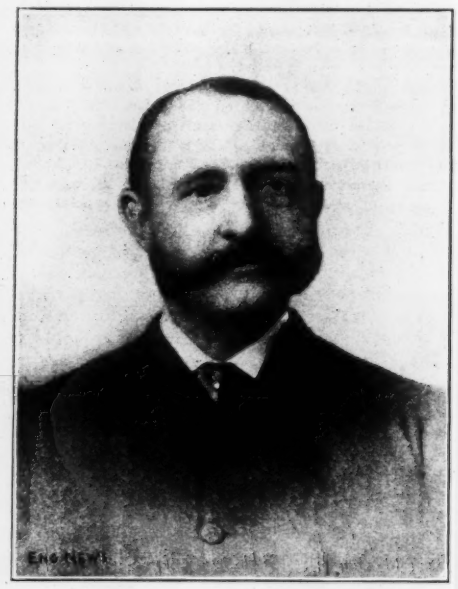
AN EXPLOSION IN A FERTILIZER PLANT in Philadelphia, Pa., May 3, wrecked one of the buildings and a fire followed which completed the destruction of the plant. Two men in the building were killed and 16 others in the yard outside were injured. The plant was the property of the M. L. Shoemaker Co., situated at East Venango St. and Delaware Ave. Reports state that a 2,000-gal. tank of oil exploded.

AN EARTHQUAKE AT CARTAGO, COSTA RICA, at 6.50 p. m., May 4, destroyed practically every building in the city. Reports of May 9 give the number of dead so far recovered from the ruins as more than 1,000. The most substantial building in Cartago was the peace palace, erected at a cost of $100,000 through the generosity of Andrew Carnegie. Most of the buildings were one or two-story structures with plaster walls. The earth-shock at San Jose, about 15 miles from Cartago, was very much less violent and caused only trifling damage.

A COAL MINE EXPLOSION AT PALOS, ALA., May 5, entombed about 130 miners in mine No. 3 of the Palos Coal & Coke Co. The explosion was a most violent one. Its flame issued more than 100 ft. from the mouth of the mine and caused the death of one man at the surface, who happened to be passing by at the moment. The fan was disabled but was repaired and put in operation again within a few hours. The state mine inspector and men from the U. S. Geological Survey's station at Knoxville, Tenn., were in the district investigating the Mulga mine, where a disastrous explosion occurred April 20, and hastened to Palos to conduct the work of rescue. On the evening of May 8, the bodies of 70 men had been recovered and none had been found alive.

RAILWAY ACCIDENTS IN THE UNITED STATES during the last three months of 1909 are recorded in accident bulletin No. 34, recently issued by the Interstate Commerce Commission. The number of persons killed in train accidents was 244 and the number injured was 4,149. Accidents of other kinds, including injuries to employees while at work and to passengers in getting on and off cars, bring the totals for the quarter up to 1,073 killed and 21,849 injured. These figures do not include injuries to trespassers.

The number of passengers killed in train accidents was 39, as compared with 56 in the preceding quarter. The total number of passengers killed in all classes of accidents was 105. As usual, more deaths resulted from falling from cars while getting on or off than from



Hiram Snyder.

any other one cause. The number of passengers' lives lost in this way during the quarter was 50.

The number of collisions reported was 1,745 and derailments numbered 1,461. The total number of collisions and derailments (3,206) is greater than in the same quarter of 1908, but is less by about 700 than in the corresponding quarter of 1907.

A POWDER MILL EXPLOSION at Hull, Que., May 8, killed eleven persons and injured about 20 others. The explosion was caused by a fire at the plant of the General Explosives Co. of Canada. The plant is situated near the outskirts of Hull and on Sunday, the day of the explosion, was attended only by a watchman. The fire broke out at about 5 o'clock in the afternoon and attracted a crowd of spectators from a nearby baseball game, who underestimated the safe distance from which to watch the fire. The main magazine of the plant contained four tons of "virite" and was a masonry building with walls 2 ft. thick. The explosion of the "virite" demolished the building and hurled large rocks from its walls to a distance of many hundred yards. A number of the spectators were struck and killed by flying rocks and persons in neighboring houses were killed by stones which fell through the roofs or walls. In all about 30 houses were damaged and ten of these are reported to have been wrecked beyond hope of repair. It is estimated that about 50,000 windows were shattered by the shock of the explosion in Hull and Ottawa, including many of heavy plate glass in the business districts.

THE PREVENTION OF ACCIDENTS AND INDUSTRIAL liability insurance is to be discussed on the afternoon of May 17 at the convention of the National Association of Manufacturers, to be held at the Waldorf Astoria Hotel, New York City. The attendance of all manufacturers and employers of labor is requested, regardless of whether or not they are members of the Association.

THE BATTLESHIP "MAINE," which has rested on the bottom of Havana Harbor, Cuba, since its sinking on Feb. 15, 1898, will shortly be raised. On May 4, the Senate passed a bill appropriating $100,000 and directing the raising of the wreck by the Secretary of War. The bill had previously passed the House and the President signed it on May 9.

TRANSATLANTIC WIRELESS TELEGRAPH service between Glace Bay, New Foundland, and Clifden, Ireland, which has been interrupted since the burning of the Glace Bay Station on Aug. 21, 1909 (see Engineering News, Aug. 26, 1909, pp. 228 and 235), was resumed May 7, when press despatches were transmitted. A new station, with improved apparatus, has been erected in a more advantageous position, it is reported, than that of the old station.

WIRELESS TRAIN DESPATCHING is reported as being experimented with by the Union Pacific R. R. for lines in the storm belt of Nebraska and beyond. This system is being tried to prevent the troubles arising from the periodic demoralization of the telegraph service.

CONCRETE BARGE AT PANAMA COMPLETED.—The first of the three concrete barges to be constructed for use in connection with the hydraulic operations in the Pacific Division was successfully launched on Wednesday, April 20. The barges are being built, one at a time, on the west bank of the Canal nearly opposite Corozal. The completed barge draws about 3 ft. of water, and when mounted with dredging pump, motor and equipment, weighing approximately 60,000 lbs., it is expected that it will draw an additional 9 ins. The amount of reinforcing material in the construction of the remaining two barges will be less than in the first, which will materially reduce the weight in the aggregate. One-half inch wire mesh No. 12 will be used in the wall construction of the other two barges, instead of $\frac{1}{4}$-in. No. 12. The completed barge will probably be towed to the point where it is desired to begin operations before the dredge pumps and other machinery are installed on board of it.—"Canal Record," April 27, 1910.

THE CHAGRES RIVER WAS CLOSED AT GATUN on April 22-25, 1910, and the water thus dammed back until it can rise above El. 10, when it will discharge through the spillway which occupies the high ground at midlength of the dam. Depending on the amount of water brought down by the river, elevations of 14 to 20 will be obtained, i. e., flow-heads of 4 to 10 ft. in the spillway. The East Diversion and the old French canal were closed nearly two years ago, by dumping of material in the east half of the dam. Since that time the entire flow has gone through the West Diversion, until the present closure. Gatun Lake began its existence with this closure. The "Canal Record" of April 27 states that the minimum area of the lake at present will be 13.8 sq. mi., corresponding to spillway floor level. At El. 20 the area is over twice as great, 29.2 sq. mi., and the stage of the Chagres will be affected as far as Tabernilla.

CEMENT PRODUCTION IN 1909.—The U. S. Geological Survey reports that between 61,300,000 and 62,000,000 bbls. of Portland cement were made in 1909, worth at the mills between $52,105,000 and $52,700,000 (at 85 cts. per bbl.) These figures are an increase of at least 10,227,000 bbls., having a value of $8,557,000 over 1908. This is an increase of about 20% in both amount and value. The reported selling price averaged the same as in 1908—about 85 cts. per bbl.—although Portland cement was sold during the summer of 1909 at a figure so low as to cause a general expectation that the average price for the year would fall below that of 1908. By arrangement with the Director of The Census, and to avoid duplicate requests for data, the Geological Survey did not send out its usual inquiry forms, causing a delay in the compilation of the 1909 figures. The data given above is based on returns from about 88% of the manufacturers and on estimates for the rest.

Incomplete returns have been secured from the natural and puzzolan cement works, but the Survey estimates the production of the former at 1,500,000 bbls. valued at $675,000, at an average price of 45 cts. per bbl. This is a drop from 1908 in production of 186,000 bbls. and in value of $159,509. The average price for 1908 appears to have been 49.5 cts.

Puzzolan, on the other hand, as reported, shows a slight increase to 160,646 bbls. valued at $99,453. This is an increase in production for the year of 9,195 bbls. and in value of $3,985. The average price in 1909 was 61.8 cts. compared with 63 cts. for 1908.

UNDERGROUND TELEPHONE TRUNK LINES.—It is announced that the American Telephone & Telegraph Co., controlling the so-called Bell telephone systems about the country, will undertake the immediate placing of its trunk lines between the important centers of New York, Philadelphia, Baltimore and Washington. Applications have already been made to the Maryland State Highways Commission for permission to lay conduit along the "Philadelphia Road" and State Road No. 1, leading from Baltimore to Philadelphia and Washington, respectively. This change from overhead to underground trunks is stated to be undertaken as a result of experiences like that during the storm of March 4, 1909, when thousands of poles were broken down and communication between these important cities was completely shut off for a few days and crippled for weeks.

THE BOSTON TUNNEL proposed to connect the North and South railway stations will not be undertaken this year. The joint Board on Metropolitan Improvements

has submitted a report to the legislative committees which have been considering the tunnel project recommending that the matter be postponed for the present. The following is quoted from the report:

As to the construction of a tunnel between the North and South stations, conferences have been held with his honor the mayor, the corporation counsel and the city engineer of Boston, and with the officials, counsel and engineers of the New York, New Haven & Hartford Railroad, the Boston & Maine and the New York Central.

As a result of these conferences, and our further independent considerations of the matter, it appears that the railroads, the mayor and the members of this board are favorable to the building of a tunnel at the expense of the railroads, but that the problem involves so many considerations, and at this time is complicated by so many uncertainties, that the Board cannot now submit a draft of a bill which it can recommend for passage at this session of the Legislature.

While this is the conclusion of the Board, it believes that an adequate bill may be prepared in time to embody the same in its final report to be made at the opening of the next session of the General Court.

A CITY PLANNING AND IMPROVEMENT EXHIBITION will be held at Berlin, Germany, in May and June of this year. The following subjects will be included:

(1) Means for traffic, and traffic systems.
(2) Parkways, boulevards, playgrounds and cemeteries.
(3) Streets, public squares, bridges, ornamental fountains, and monuments and their suitable locations.
(4) Historical development of large cities.
(5) The city proper, the business section, the residential quarters, various modes of living, and the planning of new streets.
(6) Enlargement plans, suburbs, garden cities and workingmen's quarters.
(7) Creation of new cities.
(8) Literature on City Building and Planning.

A series of 18 lectures, many of them illustrated by lantern slides, will be given in connection with the exhibition. The general secretary of the exhibition is Dr. Werner Hegemann, Marchstreet No. 9, Charlottenburg, Germany. For the foregoing information we are indebted to Mr. William Paul Gerhard, of New York City, who is now abroad.

CANADIAN CANAL TRAFFIC during the year ending June 30, 1909, is summarized in the Montreal "Gazette" as follows:

	Tons.
Sault Ste. Marie	27,861,000
Welland	2,025,000
St. Lawrence	2,410,000
Chambly	752,000
St. Peters	79,000
Murray	102,000
Ottawa	336,000
Rideau	91,000
Trent	59,000

The Sault Canal, as is well known, shares with the canals on the United States side of the Sault the enormous ore traffic from the head of Lake Superior and the return traffic in coal. The Welland Canal, which passes vessels from Lake Erie to Lake Ontario, and the St. Lawrence Canals, which enable vessels going from Lake Ontario to tide-water at Montreal to pass around the various rapids of the St. Lawrence, account for the bulk of the canal traffic of Canada, aside from the traffic at the Sault. The only other two canals which have any considerable traffic are the Chambly Canal, through which vessels pass from the St. Lawrence River to Lake Champlain, and the Ottawa Canals around the rapids of the Ottawa River between the city of Ottawa and the St. Lawrence. It will be seen that all of the Canadian canals having considerable traffic are really short links in a lake or river navigation system. On inland canals, of which the Rideau and the Trent are examples, the traffic is so small that it is far from justifying the expenditure which has been made upon them.

A STORAGE-BATTERY STREET CAR has been placed in trial service on the 125th St. crosstown line of the Third Ave. R. R., New York City. This is a part of the trials being made by Mr. F. W. Whitridge, Receiver of the company, to develop a self-contained motor vehicle to replace 25 old horse cars still operated by the company. The gasoline-electric car, described in Engineering News, Dec. 9, 1909, was the first type tried. The present storage-battery car is being operated for comparison with the gasoline-electric which has been successfully used for five months. The storage-battery car is described at length in the "Electric Railway Journal," of April 23, from which the following figures are taken.

The body of the new storage-battery car was formerly a horse car in service and with its truck weighed 7,200 lbs. The construction of the car body has been changed in very few respects, aside from the addition of vestibules with folding doors and disappearing steps to permit of prepayment operation. The body is 17 ft. 10 ins. over the corner posts and has 4-ft. platforms. It seats 26 passengers and, including all equipment, weighs 6 tons or 461 lbs. per passenger. Owing to the haste with which the car was equipped, the truck was supplied with heavy cast-iron journals and cast-iron wheels, the latter weighing 235 lbs. each, but these are to be replaced by cast-steel parts which will weigh only one-half as much. The original horse-car brakes have been retained and are giving satisfaction.

Because of the light weight of the car and the use of roller bearings in the journal boxes and ball bearings in the armature journals, two 5-HP. motors are required for operating at the schedule speed of 7 to 8 mi. per hr. making eight stops per mile. In fact, the car is so light that it can be easily pushed along a level track by one man. Eventually, this car will be operated on streets where the speeds will be only 6 mi. per hr. The car body is mounted on a truck which is made up entirely of commercial riveted angles. Each pedestal carries three helical springs and is made of 5/16-in. angle iron. Although the present truck is riveted only, the company would rivet and weld any future trucks in case it should decide to use additional storage-battery cars.

The batteries are of the Gould type "TH," pasted design, 29 plates per cell and 44 cells per set. At 84 volts, the battery has a rating of 420 amp.-hours. The batteries are placed under the longitudinal seats on each side. There are four crates of five cells each, and eight crates of three cells each. The battery covers are screwed down tightly. The battery gases are carried off by the natural ventilation which is afforded when the movement of the car sends air through a pipe on each side of the car. As this air passes over the batteries it drives off the odors and exhausts them under the step at the back of the car. There is said to be no odor in the car from the batteries.

The motors are an automobile type and operate at 1,200 r. p. m., on 40 amps., 84 volts. The car wheels are driven from the motors through geared chains.

It was observed from the data on a test run of the battery car that it could be operated for 70.176 miles on one charge at a schedule speed of 6.78 mi. per hr., including eight stops per mile. The power consumption per car-mile under these conditions was 0.496 KW.-hrs., or about 83.3 watts per ton-mile. In the service runs, with 9.62 stops per mile, the power consumption per ton-mile was 90 watts. The question of upkeep is still unsettled.

RECORDS OF GASOLINE-ELECTRIC STREET CAR.—The performance of the gasoline-electric street car described in Engineering News, Dec. 9, 1909, and which has been in trial operation for five months on the lines of the Third Ave. R. R., New York City, is reported for March in the "Electric Railway Journal," April 23. The tabulated data is reprinted below:

Revenue fares	12,084
Transfers and passes	3,833
Revenue miles	2,015
Dark miles	56
Gasoline, gals.	1,121
Cylinder oil, gals.	26.5
Platform expenses	$154.54
Motor grease	$7.32
Other expenses, including two brake shoes	$30.25
Gasoline per revenue mile, 0.5563 gal., at 11.35 cents	6.314 cents
Cylinder oil per revenue mile, 0.01315 gal., at 38.50 cents	.506 cent
Platform expenses per revenue mile	7.67 cents
Motor grease per revenue mile	0.363 cent
Other expenses per revenue mile	1.501 cents
Total expenses per revenue mile	16.354 cents
Gasoline per mile of gross miles, .5413-gal. at 11.35 cents	6.144 cents
Cylinder oil per mile of gross miles, .0128-gal. at 38.50 cents	.493 cent
Platform expenses per mile of gross miles	7.462 cents
Motor grease per mile of gross miles	.353 cent
Other expenses per mile of gross miles	1.460 cents
Total expenses per mile of gross miles	15.912 cents
Total revenue per revenue mile	29.985 cents
Total revenue per mile of gross miles	29.174 cents
Total revenue for month of March	$604.20
Total cost of operation, March	$329.55

A STEEL TRUSS ROOF WAS RAISED ONE STORY in the German navy yard at Kiel recently, according to a note in "Der Eisenbau" of April, 1910. One of the smaller shop buildings of the yard was to be enlarged by adding a second story; this required raising the entire roof about 20 ft. The roof consisted of steel trusses carrying plaster board, and very careful, uniform lifting was necessary, both to avoid injuring the roof covering and to avoid damage to the steel frame. The work was done by erecting at each end of each truss a timber post higher than the final height of roof, and suspending a 5-ton chain block from the top of the post to carry the end of the truss. A central support was also obtained for each truss, by blocking up on a crane runway which extended through the middle of the shop and placing two jacks on this blocking under each truss. Then the chain hoists and the jacks were set in motion simultaneously, lifting the roof in successive stages of 1 in. Levels were taken frequently to keep a check on the uniformity of lifting. When the roof had been lifted 8 ft., the columns and beams of the new second floor were put in, and these were used for further supports in the remainder of the lifting. The work was completed without accident and with no injury to the roof covering.

HYPOCHLORITE OR BLEACHING POWDER is being used to treat the water-supply of Toronto, Ont. About 42,000,000 U. S. gals. per day are being treated. The use of hypochlorite began on March 19, 1910, due to an outbreak of typhoid fever attributed to leakage of polluted lake water into the water-works intake. The hypochlorite is being introduced at what is known as the south tunnel shaft, a mile from the pumping station. At this point a temporary dosing plant was installed, consisting of ten 55-U. S. gal. barrels feeding through taps near their bottom into a shallow V-shaped galvanized trough. This trough in turn discharges into a constant-head pail having a pipe outlet which can be so controlled as to give the desired rate of application of hypochlorite. The quantity discharged is 1.2 U. S. gals. in 50 secs. At the outset 4 lbs. of the bleach were mixed with 45 U. S. gals. of water, but an analysis of the bleach showing it to contain only 16.6% of chlorine, the quantity of bleach was increased to 6 lbs. per 45 U. S. gals. of water. The stirring is done by hand, no other means being available in the temporary plant. We are informed by Mr. C. H. Rust, M. Am. Soc. C. E., City Engineer of Toronto, that

The whole arrangement is crude pending the Medical Health Officer's decision as to how long the treatment should be continued. The results, however, have been very satisfactory so far, and we have decided to continue the process for some little time, and are now making arrangements to put up a suitable plant, and expect to obtain better results and to effect a considerable saving in the operation.

HEAT CONDUCTIVITY OF CONCRETE.—In a reinforced-concrete building having floors 8 ins. thick with no wood surface, a battery of boilers was located in the basement. The metal breeching, which is about 3 ft. square in the cross section and unprotected by any insulation, came only about 6 ins. below the under side of the floor above. This floor became sufficiently hot to set fire to some baled paper stored in the first story on two different occasions. A later examination developed the fact that the floor was hot enough to ignite a match laid upon it.

While it is well known that concrete is an excellent heat insulator, this condition illustrates that it has some limitations and will take up and hold heat applied at short range even in a fireproof building. A much greater space than 6 ins. should be required between any floor or other member and anything so hot as a boiler flue.—Quarterly of the National Fire Protection Association, April, 1910.

THE SALE AND SHIPMENT OF RADIUM from the laboratory of the Austrian Government at Joachimsthal, Bohemia, is described as follows in an article by George N. Ifft, U. S. Consul, Nuremberg, Germany, published in the "Mining World," April 23, 1910:

Radium is one of the most expensive things in the world, and the Austrian Government has just fixed the price for a milligram (the one-thousandth part of a gram) at 400 crowns ($81.20). It is impossible to deliver radium in absolutely pure form, and it is therefore prepared for sale in a chemical combination and, as a matter of fact, as radium-barium-chloride.

At present this radium preparation is manufactured in forms and qualities which are certified and guaranteed by the government institute of the Vienna University. Each radium preparation is inclosed in a round, so-called radium-cell, which has a diameter of 21 mm. and a thickness of 9 mm. Each cell is made in the form of a case that screws together, the material of which is nickeled brass. The bottom of the cell is run full of lead, in which is sunk a small square hole, and in this hole is stored the radium preparation. This radium cell is then closed with a mica plate, and it is thus not necessary to open this cell in order to utilize the radium ray.

Every radium preparation is also officially stamped and consecutively numbered. These precautionary measures and rules are regarded as necessary on account of the unusually powerful chemical action of radium and that no unforeseen injuries may result through careless handling of the same.

To purchase radium from the Austrian Government one must have more than just the necessary money to pay the price, for in order to guard against the misuse of the same, this rare mineral will be sold only to scientific institutions or to learned men. Delivery is made at the risk of the purchaser, and as yet there are no rules regulating the use of the mails for such purpose. Up to date not even a single milligram of radium has ever been sent by mail. It has always been forwarded by special messenger. Since its discovery, radium has become relatively cheap. Under the quotations of the Austrian Government it is worth only about $36,500,000 per pound.

Personals.

Mr. Maurice H. Thatcher has been appointed a member of the Isthmian Canal Commission.

Mr. C. A. Wilkinson has been appointed Superintendent and Chief Engineer of power plants of the Coney Island & Brooklyn (street) Ry., Brooklyn, N. Y.

Mr. Harry C. Ross, Master Mechanic and General Superintendent of Construction for the Consolidated Gas, Electric Light & Power Co., of Baltimore, Md., has been dismissed from that position.

Mr. C. F. Franklin, who resigned some months ago as President and General Manager of the Toledo & Western R. R., has been appointed General Superintendent of the Winona Traction Co., with headquarters at Warsaw, Ind.

Mr. Theodore Voorhees, M. Am. Soc. C. E., Vice-President of the Philadelphia & Reading Ry., has been elected President of the Bureau for the Safe Transportation of Explosives, succeeding the late Dr. Charles B. Dudley.

Mr. George N. Merrill, M. Am. Soc. C. E., and Mr. Robert M. Sears have formed a partnership as civil engineers and surveyors under the firm name of Merrill & Sears, with offices at 274 Main St., Springfield, Mass. The new firm will continue the practice of George N. Merrill & Co.

Mr. Frederick M. Whyte, M. Am. Soc. M. E., has been appointed General Manager of the New York Air Brake Co. and will assume the duties of this position on June 1. He will withdraw at that time from his present position as General Mechanical Engineer of the New York Central Lines.

Mr. J. W. Johnson, formerly a locomotive foreman of the Chicago Great Western R. R., has been appointed